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ELECTRIC TRACTION AT BIRMINGHAM.

THE report of the directors of the Birmingham Central Tramways Company, Limited, contains statements of a hopeful character. Taken as a whole, the shareholders may view the last year's working with satisfaction. The cable lines have more than maintained their earning capacity, and the electric lines, which, in the first half of the year, were suffering from exceptional difficulties of construction and maintenance, have apparently overcome those drawbacks, and show a substantial and steadily improving profit. The electric cars started running on July 24th, 1890, and they carried up to June 30th, 1891, 1,144,718 passengers over 138,396 miles. The revenue during this period amounted to £8,732, and the gross expenditure to £5,711, leaving a balance of £3,021. An examination of the working accounts reveals the following interesting figures, all expressed in pence or fractions of a penny per car mile run. Under the heading *electric haulage*, we find wages, 2·6; fuel, 1·66; stores, ·73; water and lighting, ·07, and sundries, ·09, giving together 5·15 pence; under *machinery*, material, ·29; and for *car repairs*, wages, ·6, and materials 1·33 pence per mile; total traction expenses, 7·37 pence.

Electrical engineers, accustomed to computing costs of energy for traction purposes, will express surprise at the abnormally high figure of 1·66 pence per mile for fuel alone. Coal, at Birmingham, is not very expensive, but allowing 18s. per ton for this commodity, delivered alongside the boilers, we obtain a consumption of 16·6 lbs. per mile. If the cars make an average speed of six miles per hour, and we are informed that this is the case, the hourly consumption of fuel per car reaches the total of nearly 100 lbs., which, with moderately efficient appliances, should suffice for about twice the distance given. The car repairs, again, rated at 1·93 pence per mile, appear to point to a very high depreciation of motors and accumulators, both of which ought to show much better results during the next year's running.

The accounts of the *horse department* for haulage come out as follows:—Wages, 2·44; forage and bedding, 3·72; veterinary and shoeing, ·4; water and gas, ·06; harness repairs, ·16; stable utensils, ·04; sundries, ·08; and renewals, ·43; together, 7·33 pence per car mile. Adding, as in the case of the electric line, the *car repairs*, for they cannot be separated, wages ·28 and materials ·26, we obtain a total of 7·87 pence for horse haulage, or little more than the expenses with the storage battery cars, whilst the general expenses, notwithstanding the great consumption of fuel, are only 5·15 pence with the electric, against 7·33 pence with the horse cars; the items of car repairs stand at 1·93 to ·54 respectively. But in the case of electric cars the mechanism attached to the vehicles and accumulators are included, whereas in the horse car account renewals of animals and harness stand separated from "vehicle repairs." Altogether, the prospects of the electric cars at Birmingham appear hopeful, and it is reasonable to expect that with more experience and further improvements the electric haulage costs will soon show a very decided economy over the horse traction expenses. The directors of the Birmingham Central Tramways are to be congratulated upon the progressive spirit displayed in giving electricity a thorough trial, and we hope that they will not regret this important step.

AN ELECTRIC LIFEBOAT.

IT is announced that there is to be a new application of the Sims-Edison method of electrically propelling and controlling torpedoes, namely, an adaptation for the purpose of propelling lifeboats. Any invention that may add to the efficiency of the existing invaluable means of saving life must be heartily welcomed, but one hesitates to believe that any great importance can be attached to the announcement, and, least of all, that it means that ordinary lifeboats are to be cleared of their usual crew and managed by two men only, no hands being left to render assistance when the wrecked ship is reached. It seems hardly credible that the almost certain chances of a controlling cable being parted, and the boat

thus rendered absolutely helpless by the terrific seas through which lifeboats have to go, have been considered as being of little account, or have been amply provided against. Nor does it appear to have been considered that a run of a mile or so is not all that a lifeboat has to do; 10 or 12 miles is often the distance that a boat has to cover in order to reach a distant wreck or disaster. Given the possibility of keeping the connecting cable intact under all conditions, and of a length of some 10 or 12 miles of the same being available, the value of the idea seems very considerable, and there may even be conditions under which, as a supplement to the ordinary fully-equipped lifeboat, the invention may be useful and practical. The fact that a propelling power many times greater than that which a full crew can exert can be obtained by the proposed system is a very great argument in its favour, and the absence of extra deadweight is of course an advantage not possessed by steam lifeboats, though since the latter contain all the elements of self-propulsion, they possess the element of independence which can hardly be estimated too highly. In any case, although the idea seems hardly a feasible one, the development of the same will be watched with interest, and it may possibly turn out to be a useful auxiliary, if nothing more.

The Proposed Crystal Palace Exhibition.

LAST Friday morning there reached us a circular from the London Chamber of Commerce marked "Urgent." It was to inform the Electrical Section that a gathering of the Committee was to be held at 4 p.m., on that day, to meet in conference the directors of the Crystal Palace Company for discussing the desirability of postponing the proposed electrical exhibition at the Crystal Palace. Considering the manner in which the scheme was brought forward, the course adopted last week will surprise nobody. The resolutions passed will be found in our "Notes" columns, and we now learn that the directors of the Crystal Palace have decided to postpone the opening of the Electrical Exhibition from November, 1891, till January 1st, 1892, on which day it will be formally opened. They could not agree to a later date without breaking faith with a large number of exhibitors who have applied for space, and who are now preparing their exhibits. With the view of promoting the success of the exhibition, the Chamber of Commerce has agreed to appoint a committee to act with the directors of the Crystal Palace Company. Over 60 well-known gentlemen have consented to act as an honorary council of advice, and judging from the names there should be no lack of sound common sense on every question which may arise.

Gutta-Percha and its Durability.

IN an article in this week's issue on a peculiar fault found in a submarine cable, there are two points which strike our attention as being of great interest. The first is: that a cable originally intended to be used for telegraphic communication in the Red Sea in 1861, should now, in 1891, be found suitable to form part of an electric light circuit working under high pressure. The second is: that a conductor insulated with gutta-percha should, after so many vicissitudes and after a life of 30 years, be found electrically suitable for working with a current of so high a potential as 2,000 volts. Surely there are not many instances where the durability of gutta-percha has come out so strongly. This speaks well not only for the quality of the material used, but also for the excellence of the manufacture. Who amongst us will venture to say that vulcanised rubber will show a life equally long?

Storage Battery Litigation in America.

IT will be remembered that three years ago the Julien Company put several storage battery cars upon the Fourth Avenue tramlines in New York. The Julien cells were then considered an infringement upon the inventions of Faure and Brush. The Electrical Accumulator Company (owning the Faure patents) and the Brush Company thereupon sued the Julien Company in a court of law and an injunction was obtained by the Accumulator Company, which, however, was evaded by means of a dry oxide powder being used in manufacture instead of the "paste paint or cement" claimed by Faure. More recently, the Brush Electric Company brought a suit against the Electrical Accumulator Company in the United States Circuit Court where Judge Coxe, who also decided the former case, sustained the storage battery patents of Charles F. Brush. This brings virtually to an end the litigation which for five years has been carried on by the Julien Company, the Brush Electric Company, and the Electrical Accumulator Company, for the control in the United States of the manufacture and sale of storage batteries made of oxides of lead supported mechanically upon metallic frames, and it removes the obstacles in the way of their introduction for purposes of lighting and traction. It is a remarkable fact that the Electrical Accumulator Company, which bought the patents from the original English E.P.S. Company, has all but been wound up soon after its victory against the Julien Company; at any rate, the factory at Newark has long been shut down, and the little business which is left is being carried on by the Electro Dynamic Company in Philadelphia. The old Julien Company has gone to the wall after its resources had been consumed in profitless pioneering and legal fighting, but it has again been resuscitated under the name of the Consolidated Electric Storage Company, holding an exclusive license throughout the United States for the Brush storage battery patents. The latest decision practically awards to the Brush Electric Company the monopoly in the manufacture of secondary batteries having a mechanically applied coating of active material. Judge Coxe, in his decision, says: "Mr. Brush was the first in this country to make the broad invention. He is entitled to the fruits of his invention. It is the policy of the law to reward him." The Brush Electric Company, it must be remembered, has never been in the market with its storage battery, although it has spent upwards of a hundred thousand dollars in experiments. It will be interesting to watch the further developments of this business in America; up to the present no one seems to have benefited by it except the lawyers.

Electricity on Windermere.

THE simple fact of placing an electric boat on Lake Windermere has caused an eloquent writer to pour out his soul into the columns of the *Pall Mall Gazette*. It is only when the newspaper writer takes up the subject that full justice is done to electricity. The electric power for the boat is derived from a waterfall, and this moves the writer to the following grandiloquent peroration:—"But the first performance of its kind in the scientific and industrial history of England (and perhaps of the world) was seen when at Cunsey Beck, half-way on the western shore of Lake Windermere, the electricity was, as a spectator expressed it, 'brewed out of a cascade'—when, instead of the mechanical force of burning coal, the mechanical force of a waterfall was poured, as it were, into the 'dynamo,' to be subjected there to the influence of a mysterious something, and to be manipulated under new conditions."

AN OBJECT LESSON IN AN ELECTRIC LIGHT SUIT.

ONE of the most interesting features, says the new American journal, *Electricity*, of the recent suit of the Edison Electric Light Company against the United States Electric Lighting Company, brought to recover for alleged infringement of incandescent lamps, was a series of illustrations specially designed to give Judge Wallace, of the District Court, a clearer idea of electrical units.

Among other things a board was prepared for representing the effect which length and cross-sectional area in a conductor have upon the resistance of the conductor. This is illustrated in fig. 1. To the left of the board are shown

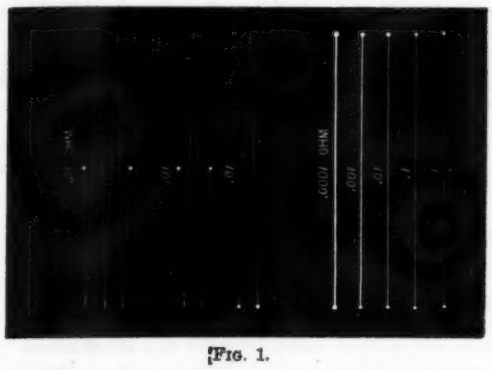
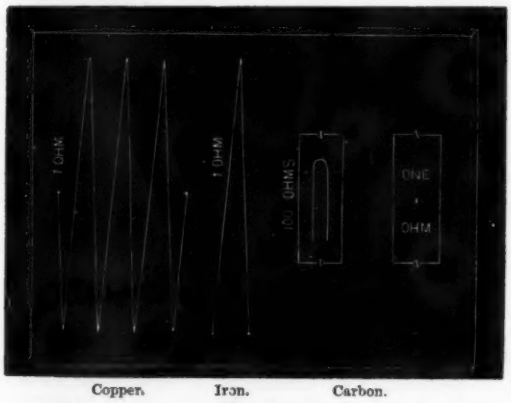


FIG. 1.

the lengths of wire of No. 14, No. 16 and No. 18 Brown and Sharpe gauge required to show a resistance of $\frac{1}{100}$th ohm. To the right, in regular progression, are the No. 0, No. 10, No. 20, No. 30 and No. 40 Brown and Sharpe gauge wire, all of the same length. These show, at a glance, the effect which cross-sectional area will have on resistance. For instance, where 1 foot of No. 40 copper wire measures 1 ohm, 1 foot of No. 0 wire measures about $\frac{1}{10000}$th ohm.

Illustration No. 2.—In the course of the argument the question of specific resistance in contradistinction to total resistance was one of constant recurrence. An exhibit was therefore devised to illustrate the relative resistance of



Copper. Iron. Carbon.

FIG. 2.

copper, iron and carbon. Where 10 feet of copper wire $\frac{1}{100}$th inch in diameter measure 1 ohm it takes but 18 inches of iron wire of the same size to measure 1 ohm; and to show the immense difference in specific resistance between these metals and carbon it was shown that $\frac{4}{100}$th of an inch of carbon of the same size as the wires was all that could be taken to measure the resistance.

Illustration No. 3.—This exhibit was prepared to illustrate the different steps in the process of manufacture through which the Edison lamp passes on its course towards completion. The globe, 1, is the article as it comes from the lamp factory; Nos. 2 and 3 are different sized glass tubes; No. 4 is a strip of bamboo, as received from Japan. These four articles are all what might be termed raw material. No. 5 is the thin filament of bamboo before carbonisation. No. 6 is No. 1 with the projection punched into shape at the top. No. 7, the next step, shows No. 6 with the bottom of the tube reamed out, and with the small tube, No. 3, attached at the top. No. 8 shows the two leading-in wires of platinum with copper wires attached. No. 9 is the rod 2 with a small bulb blown in it. No. 10 shows the last step, with the leading-in wires sealed in a tube. No. 11 shows this "inside part" with the carbon filament attached ready to be inserted in globe 7. No. 12 shows this insertion as accomplished, with

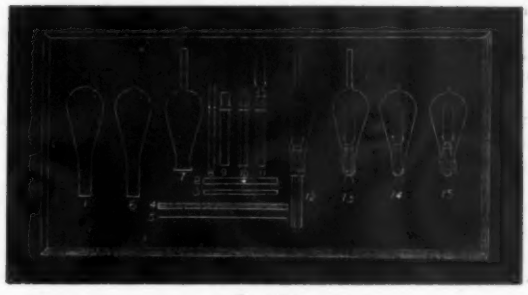
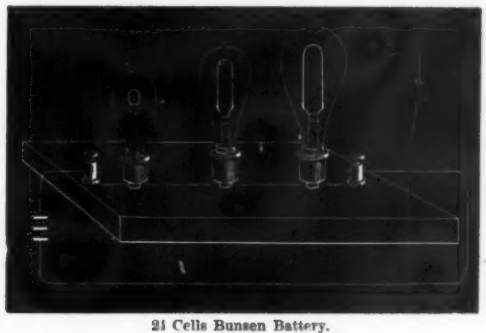


FIG. 3.

the two glass parts fused together. No. 13 is No. 12 with the unnecessary projections taken off at the bottom. The lamp is now ready for the pump. No. 14 shows the exhausted lamp as it leaves the pump room, where all the air has been extracted from the interior. No. 15 is the finished product.

Illustration No. 4.—The improvement was referred to in the suit of a combination in an incandescent lamp of high resistance in proportion to the radiating surface. To

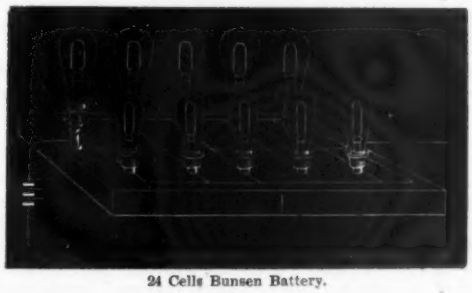


24 Cells Bunsen Battery.

FIG. 4.

show this plainly to the judge three lamps, each of the same resistance, and having radiating surfaces of 1 to 6 to sixteen, were placed in series and connected to a battery of 24 Bunsen cells. Although the same current necessarily travelled over each lamp, the lamp having the least radiating surface gave a brilliant light, while the lamp with the largest amount of radiating surface was hardly brought to a dull red.

Illustration No. 5.—The Edison counsel contended that prior to Mr. Edison's discovery of the light of the patent in suit, and its publication, no practically commercial lamp had



24 Cells Bunsen Battery.

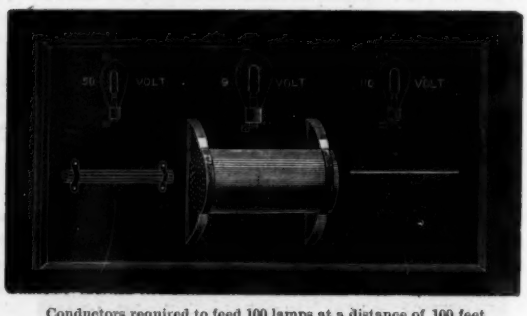
FIG 5.

ever been produced. Among the points brought in substantiation of this claim were the experiments made by Fontaine in 1878-9, in which it was found that when lamps having low resistance and large radiating surfaces were connected to a Bunsen battery, by turning one lamp on a brilliant light could be obtained. When two of these lamps in multiple

arc were turned on at the same time, the light produced by the two lamps was not equal to that thrown out originally by the first lamp, but dropped down very low; in fact, where one lamp might give 25 candle-power, the two lamps in multiple arc would not give a total of 20 candle-power. As more lamps were turned on the light would diminish rapidly, until it was found that when five were in circuit the carbons of all could hardly be distinguished by the light they gave. Fontaine was looking for practical means of sub-dividing the large lights which were obtainable in his day into small units without corresponding loss. This he demonstrated to his own satisfaction and that of the world at large to be an impossibility, as shown by the mathematical verification given to his deductions by W. H. Preece and others. This experiment was shown to the judge, just as Fontaine tried it, with the results indicated in his reports.

On the same board with the Fontaine lamps, and fed from the same battery, five Edison filamentary lamps having high resistance and low radiating surface were exhibited, and it was found that the five lamps could be turned on at the same time without any diminution in the candle-power of any, so that the light given out by the last lamp turned on was the same as that of the first. This experiment showed that although the unit of light on each of these high resistance lamps was only six candle-power, as compared with 25 candle-power in the Fontaine experiments, the subdivision of the 25 candles of light was accomplished by means of the Edison lamps without loss.

Illustration No. 6.—What seemed to strike the lawyers for the defence as a remarkably strong argument was exhibit 6, showing the relative sizes of conductors required for the



Conductors required to feed 100 lamps at a distance of 100 feet with 2 per cent. loss.

FIG. 6.

lamps known prior to Edison's time and the lamps described in his patent. At the top of the board were arranged an old style "rod" carbon, a 50-volt lamp and a 110-volt lamp, the last two having filamentary carbons. It was shown that to feed one hundred of the 110-volt Edison lamps at a distance of 100 feet with 2 per cent. loss, a No. 4 Brown and Sharpe gauge wire would be necessary. To feed the same number of 50-volt lamps five of these No. 4 wires would be necessary; while to feed the same number of the lamps known prior to Edison's patent would require four hundred of these No. 4 wires for each side of the circuit. The ratio between a 110-volt filamentary lamp and the 9-volt "rod" lamp is as one to four hundred, and where a foot of the conductor required for one might cost three cents, a foot of the other conductor would cost 12 dollars. What was therefore a commercial failure was converted by Edison's improvements into a commercial success.

TRANSFORMERS.

THOSE who read Prof. John Perry's paper given a short time ago before the Physical Society, entitled, "Mr. Blakesley's method of measuring power in transformers," should read it again after perusing another paper on the study of transformers, which is published in the August number of the *Philosophical Magazine*.

Prof. Perry is of opinion that Mr. Blakesley's method of measuring the power given to the primary coil of a transformer becomes more important the more it is studied. This method is correct according to Mr. Blakesley,

1. If the currents follow the simplest periodic law.
2. If there is no magnetic leakage.
3. If the magnetic permeability is constant.

And Prof. Ayrton and Mr. Taylor have proved that the method is correct for currents of any periodic law, the permeability varying in any way whatever. But they make the assumption that there is no magnetic leakage.

Prof. Perry, however, has gone further, and proved that Mr. Blakesley's method is correct, whatever the magnetic leakage may be.

There was some discussion at the time on Prof. Perry's paper, in which, owing to his not having described sufficiently what he meant by "magnetic leakage," the importance attached by him to this was looked upon as somewhat academic; and consequently Prof. Perry read an additional paper on May 23rd, in which he endeavoured to make his position clearer. This should also be read again after studying his latest contribution to the subject of transformers.

When we say "latest" contribution, we really mean "most recently published," for the paper was written as long ago as last February.

Prof. Perry commences by commenting upon the "vague and reckless statements" of certain writers upon this subject, and ventures to think that something may be gained by coming back to the old-fashioned method of treating it.

If, he says, the assumption be allowed of constancy of magnetic permeability, of no hysteresis, and no heating of either iron or copper by eddy currents, then what are the laws of a transformer? Let this be found out first.

On comparing the theoretic and experimental results, we shall be in a position to theorise on the effect of the new phenomena, and even this it will not be wise to do until we observe whether magnetic leakage will not account for some of the discrepancy.

If one gives numerical values to resistances, sizes of iron, numbers of windings, &c., it is quite easy to calculate everything about all the currents for a transformer with two, three, or more coils.

Prof. Perry gives a number of tables which he has compiled from exercises worked out by his students on a transformer with two coils, and considers that the figures in these tables are even of more interest just now than experimental results. In these tables the "lag" sometimes varies for no load and full load between 172°·940 and 179°·942, and as far as his own experience goes, he is unable to distinguish with any ordinary dynamometer between a lag of 175° and one of 180°.

Instead of these tables showing the effect of diminishing frequency in a given transformer, he considers that they really show the effect of keeping frequency constant, and diminishing the section or increasing the length of the iron magnetic circuit.

For the sake of beginners, it is well to state that using ampères, volts, and ohms, then we may take it that:

$$L = P^2 \frac{a\,\mu}{\lambda} \quad \frac{4\,\pi}{10}$$

$$L' = S^2 \frac{a\,\mu}{\lambda} \quad \frac{4\,\pi}{10},$$

where

L = the primary self-induction.
L' = the secondary self-induction.
P = the number of windings of the primary.
S = " " " secondary.
a = the cross section of the iron in sq. cm.
λ = the average length of the complete iron magnetic circuit.
μ = the permeability.

And if there was no magnetic leakage—that is, if all the field due to a primary current through any winding of the primary passed through every single winding of the secondary, then the mutual induction is

$$M = \sqrt{L\,L'}$$

or

$$M = P\,S \frac{a\,\mu}{\lambda} \quad \frac{4\,\pi}{10}$$

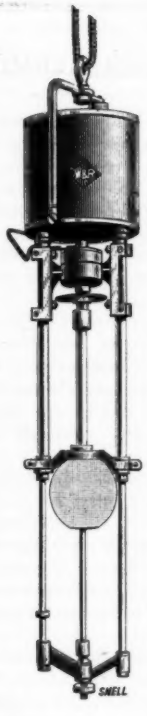
Prof. Perry takes examples from these tables, and with the aid of formulæ makes certain interesting generalisations.

And shows further, that such experimental results as are available tend to confirm the view that—effective primary volts × effective primary ampères give a result always greater than the true power, even for very great loads; a result which is to be expected if there is considerable magnetic leakage.

THE MIDGET ARC LAMP.

The great economy of arc as compared with incandescent lighting renders interesting any attempt to popularise the use of small arc lamps. For large shops, or small lecture theatres, something between the usual large arc and the ordinary incandescent lamp has long been wanted. It is absolutely necessary not only that these small lamps should possess perfect steadiness, but also that they should be so simple in construction that they may be relied on for keeping in working order without constant skilled attention.

It is a lamp which fulfils these conditions, and which we confidently recommend for general use, that we purpose noticing now. It is called the "Midget" from its small size, and is made to give 250 candle-power, using 5 ampères at an electromotive force of 45 volts, so that even with this small size of lamp we obtain one candle-power of light for the expenditure of every watt of electrical energy used.



The illustration shows the general appearance of the lamp. The smallness of the globe prevents any depth of shadow, and minimises any complaint which may be urged against the inequality of the distribution of the light.

The principle upon which the lamp works may almost be called simplicity itself. The upper part of the rods forming the frame of the lamp are hollow, and in these the lower portions slide quite easily. The bottom carbon is attached to the lower part of the frame, which is fastened to the upper portions of the lamp by a chain passing up the hollow pillar forming the upper portion of the lamp, round a pulley wheel, whose motion is controlled by clockwork, and then to the upper carbon holder which acts as a counterpoise, and slides freely between the hollow pillars forming the frame of the lamp. The motion of the pulley is controlled by clockwork, which is started and stopped by a pivotted bar, on whose under surface a number of teeth are situated.

These engage a pointer attached to the pendulum of the clock. This bar is pivotted in the centre and attached each end to iron plungers which move inside the cores of electro-magnets actuated respectively by the main and shunt circuits. When, owing to the distance between the carbon points, the resistance of the main circuit increases, and consequently the current through the shunt increases, the plunger is drawn further into the core round which the shunt circuit passes and the pendulum is released, the clockwork moves the carbons nearer together until the main circuit increases so much as to draw the other plunger into the core round which it passes, and so overpowers the effect of the shunt circuit. The bar is drawn down, the teeth engage the pendulum of the clockwork, and the carbons are maintained apart until, owing to the burning away, the same action is repeated. This action is so delicate that no inconvenience at all is caused by the intermittent feed, indeed it is scarcely noticed.

When the current is stopped the pendulum is released, owing to the action of a spring upon the bar, and the clockwork causes the carbons to remain together.

In the small box over the upper carbon holder, the current, before passing to the carbon, magnetises an iron core and lifts the upper carbon a small distance above the lower one, thus forming the arc when the current is first put on the lamp. The carbon is held up in this manner all the time the current is passing through the lamp.

The lamp is wound in three different ways, one suitable for parallel working, one for series, and one for use with alternating currents. Those which are at present in use have given great satisfaction, and to meet the growing demand Messrs. Woodhouse & Rawson, United, Limited, have stocked a large quantity of them, from which they will be able to supply orders.

THE THEORY OF MAGNETISM AND THE ABSURDITY OF DIAMAGNETIC POLARITY.

The most unsatisfactory part of the theory of magnetism is that which refers to the so-called diamagnetic bodies. This part of the theory is so beset with absurdities and contradictions, that it is necessary to examine it closely and to point out the true explanation of the behaviour of these "diamagnetic" bodies before we can state a general theory.

This forms the subject of a contribution to the August number of the *Philosophical Magazine* by Mr. J. Parker, M.A., Fellow of St. John's College, Cambridge, who proposes to consider the subject carefully and completely by means of which it is hoped the disputed points will be settled to the satisfaction of everybody.

In his first instalment Mr. Parker employs none but the simplest mathematics and avoids unnecessary references to the physical theories of magnetism, and he proposes to bear this in mind throughout.

Although we strongly recommend our readers to peruse the original paper in the *Philosophical Magazine*, we give the following abstract for the benefit of those who may not have time or opportunity to do this.

The property which distinguishes the so-called diamagnetic bodies like bismuth and copper from the paramagnetic bodies, *e.g.*, iron, is generally exhibited by a well-known classical experiment, but instead of taking this experiment as the starting point, Mr. Parker prefers, for the sake of simplicity, to take another, which is easier to understand. This is an ideal experiment which, however, is admissible, because not only is it equivalent to the usual classical experiment (which he describes), but the inferences drawn from both are the same.

In the ideal experiment a powerful electro-magnet whose poles are at a considerable distance apart is taken, and near either pole, P, a small piece, M, of the substance to be tested is suspended by a thread. On exciting the magnet if M be a piece of iron, it is drawn nearer the pole, P, while if it be a piece of bismuth it would be driven further away from it *vide* fig.

The explanation that is usually given of these phenomena may be divided into two parts :—

(*a*). It is assumed that the pressure of the air is strictly uniform all over the surface of N, from which it would follow that the pressure of the air can have no influence in causing the body, M, to approach or recede from the excited pole, P.

(*b*). It is then supposed, as a necessary consequence, that when the electro-magnet is excited, a piece of iron is attracted to the pole, P, and that a piece of bismuth is repelled.

Mr. Parker denies that (*a*) can be correct, and proceeds to

show that in the space around the excited pole, P, the pressure of the magnetised air varies from point to point.

He modifies the explanations (*a*) and (*b*) as follows :—It must be admitted that the pressure of the magnetised air is not quite uniform over the surface of M, but it may be supposed that the resultant pressure is so small in comparison with the action of the pole, P, that it is still necessary to divide bodies into two classes, viz. :—

i. Those which are attracted by the pole.
ii. „ „ „ repelled „ „ „

Now, recollecting that the so-called diamagnetic bodies which, when the magnet is excited, recede from the pole, P, are caused to do so by a force which is evidently very minute, it will be easy to show that a very slight inequality in the pressure of the air on the surface of M is quite competent to produce the phenomena observed. Diamagnetic bodies may, therefore, be really attracted to the pole, P, and only caused to recede from it by an excess in the pressure of the air on the side of M next to P over the pressure on the side remote from P; just as a balloon is attracted to the earth and only caused to ascend by the pressure of the air.

Mr. Parker illustrates his argument by supposing M to be a cube, each of whose edges is one centimetre, and hung symmetrically with respect to the magnet pole; he then deduces calculations which may well throw doubt on the common theory of diamagnetism.

But the theory has still one apology left. It is found that diamagnetic bodies retain their characteristic property in a comparatively perfect vacuum. This, however, is explained by Mr. Parker, who observes that if, in the ideal experiment, the attraction of the pole, P, on the body M were strictly zero, the body, M, would be driven away from the excited pole, P, by the pressure of the air, however good the "vacuum" might be, short of absolute perfection. Hence, if the attraction of P on M be not strictly zero, but exceedingly small, it will be necessary to reduce the density of the air very nearly to zero before this attraction can make itself manifest. We shall give a further notice of Mr. Parker's work.

TESLA'S ELECTROLYTIC METER.

THIS meter consists of an electrolytic cell, through which extend two conductors parallel and in close proximity to each other. These conductors are connected in series through a resistance, but in such manner that there is an equal difference of potential between them throughout their entire extent. The terminals of the conductors are connected either in series in the circuit supplying the current to the lamps or other devices, or in parallel to a resistance in the circuit, and in series with the translating devices. Under such circumstances a current passing through the conductors establishes a difference of potential between them which is proportional to the strength of the current, in consequence of which there is a leakage of current from one conductor to the other across the solution. The strength of this leakage current is proportional to the difference of potential, and therefore, in proportion to the strength of the current passing through the conductors. Moreover, as there is a constant difference of potential between the two conductors throughout the entire extent that is exposed to the solution, the current density through such solution is the same at all corresponding points, and hence the deposit is uniform along the whole of one of the conductors, while the metal is taken away uniformly from the other. The resistance of one conductor is by this means diminished, while that of the other is increased, both in proportion to the strength of the current passing through them. From such variation in the resistance of either or both of the conductors forming the positive and negative electrodes of the cell, the current energy expended may be readily computed.

The method of using this device, and computing by its means the energy of the current, will be readily understood. First, the resistances of the two conductors, respectively, are accurately measured and noted. Then a known current is passed through the instrument for a given time, and by a second measurement the increase and diminution of the resistances of the two conductors respectively taken. From these data the constant is obtained, that is to say, for example, the increase of resistance of one conductor or the diminution of the resistance of the other per lamp-hour. These two measurements serve as a check, since the gain of one conductor should equal the loss of the other. A further check is afforded by measuring both wires in series with the resistance, in which case the resistance of the whole should remain constant.

After each measurement or registration of a given variation of resistance in one or both conductors, the direction of the current is changed or the instrument reversed, so that the deposit will be taken from the conductor which has gained and added to that which has lost. By this method it is possible to read off directly the amount of the energy expended by means of a properly-constructed ohm-meter, and without resorting to weighing the deposit; it is not necessary to employ shunts, for the whole of the current to be measured may be passed through the instrument; and the accuracy of the instrument, and correctness of the indications, are but slightly affected by changes in temperature. In addition to these advantages the arrangement possesses the merit of economy of energy, and simplicity in construction.

THE NEUHAUSEN ALUMINIUM WORKS.

CONSIDERING that the subject of producing aluminium for commercial purposes is now receiving more attention at the hands of the engineering world, it may be interesting if reference is made to the Neuhausen works in Switzerland. The information hitherto published regarding this important establishment is exceedingly meagre, but the company recently forwarded a detailed description of the plant there employed to a London correspondent, who sends us the following condensed notice :—

The works are situated at Lauffen-Neuhausen, near the grand fall of the Rhine at Schaffhausen. Originally they were iron works, well known on account of the excellency of their products; and the establishment prospered for a long time, this being mainly due to the energy of the proprietors —the Neher family. The extension of the railway system, however, opened new markets for foreign manufactures, which began to be more largely used in Switzerland, and this fact, combined with the difficulty of obtaining raw materials, darkened the prospects of the undertaking. After considering this state of affairs, M. Naville-Neher, the principal of the well-known firm of Escher Wyss and Co., of Zurich, and M. George Neher resolved to impart new life into the works by commencing a new industry. These two gentlemen were the first to propose to utilise the water of the Rhine in the production of aluminium, and they have formed the heart of the whole enterprise.

It was then intended to obtain from the Rhine a total of 15,000 horse-power. Preparations were made to carry out this scheme which, however, failed, owing mainly to the outcry that the natural beauty of the river would be destroyed. It was perhaps as well that the project as elaborated at that time was not practically executed, and for reasons which it will be unnecessary to mention. M. Naville-Neher was, however, determined that the aluminium problem should be solved. At his instigation M. Heroult, a young French metallurgist, entered into relation with the owners of the Lauffen iron works and with the most important Swiss engineering firms, with a view to working on a large scale his aluminium process which had yielded good results on a small scale. The first trials conducted at those works were very successful, and the installation was gradually increased until in August, 1888, the new Swiss Metallurgical Company had plant of 300 H.P. in operation. It is noteworthy that simultaneously with the experiments of M. Heroult at Neuhausen, Dr. Kiliani, of Berlin, put into practice in the name of the General Electricity Company (Allgemeine Elektricitäts Gesellschaft) of that city a process of extracting aluminium direct from alumina by electrical means. The news of these simultaneous experiments came under the notice of the directors of both companies, and it was considered advisable to amalgamate the two aluminium enterprises. This combination was soon effected, and in November, 1888, the Société Anonyme pour l'Industrie de

l'Aluminium was constituted at Zurich with a capital of £400,000. By this means the directors were enabled to put into operation a unique installation.

According to the concession granted by the State of Schaffhausen in February, 1889, the company has the right to draw from the Rhine above the Falls water equivalent to 4,000 effective horse-power. The execution of the hydraulic works and the construction of the buildings were entrusted to Colonel Locher, the builder of the Pilatus railway, and work according to his plans was commenced in the same month of that year. It was decided to arrange the plant so as to economise space as much as possible, and in order to effect this a vertical disposition was chosen, that is to say, with the dynamos placed above the turbines and the armatures coupled direct to the vertical turbines. The old plant of the Swiss Metallurgical Company, with 300 horse-power at its disposal, occupied a length of 50 feet, whilst the new installation utilises in about the same space 1,500 H.P. Messrs. Escher Wyss and Co., who were commissioned to instal the turbines, adopted the Jonval type, which best fulfilled the conditions required. The supply of water is obtained above the Rhine Falls from a canal, 164 yards long, formed by a masonry dam in the river. In the centre of this canal there has been built the turbine house of the Swiss Industrial Company; it contains a Jonval turbine of 400 H.P., and water is led to it by a vertical shaft. The water for the Aluminium Company is taken from the lower end of the canal by a conduit of pipes constructed of riveted plates, and 66 yards in length. This conduit has an internal diameter of 8 feet 4 inches, and the water enters it through an iron rack, which can be closed by a valve. The lower extremity of this conduit is connected at right angles by means of a strong conical tube with the distribution or feed conduit, which radiates into three tubes for the three turbines. These comprise two large machines, each built to yield 600 H.P., and driven at 225 revolutions, and one to give 300 H.P. at 350 revolutions.

The dynamos, which, as already stated, are arranged vertically over the turbines and coupled direct to the latter, are of the Brown type, and were built by the well-known Oerlikon Engineering Works. Two of these machines are each of 600 H.P., and are used in the production of aluminium; the third dynamo is of 300 H.P., and serves partly to excite the two large machines. From the latter the current is collected from the commutator in twenty-four places, and in each part by a group of five brushes 2 inches wide, there being therefore 120 brushes to each machine. The two large dynamos, although constructed to yield normally 14,000 ampères at 30 volts, or 420,000 watts in continuous work, can be pushed to give 500,000 watts. The output of the third dynamo is normally 3,000 ampères at 65 volts, or 195,000 watts; this can be augmented to 250,000 watts. The process used is the Heroult-Kiliani method, and is now tolerably well known. It consists essentially in the fusion of alumina, and in its decomposition by the electric current, without the addition of any other conductor or flux. The Neuhausen works have now been in operation for some time with great success, and, in addition to the above plant, there are a foundry, forge, furnaces, repairing shops, &c., in operation.

M. POPP AND THE PARIS MUNICIPAL COUNCIL.

[COMMUNICATED.]

THE lighting of the Bercy entrepôt led to a lively discussion at one of the last meetings of the Paris Municipal Council prior to its rising for the vacation, and also to M. Popp's success over a rival tenderer, which success has led to a slight suggestion of jobbery. The following is the account of that portion of the sitting relating to the subject under notice:—

M. COCHIN (speaking for the Third Commision): Gentlemen, we have before us two applications relative to the lighting of the Bercy entrepôt. The Administration attaches great importance to the solution of this question. M. Lyon Alemand complained the other day of the insufficiency of the police. Light will singularly facilitate supervision. M. Douai offered the following conditions: Supply of light to tradesmen at the rate of 12 c. per hectowatt-hour, so long as the consumption does not exceed 1,200,000 watt-hours per day, this rate to fall to 11 c., 10 c., and 9 c. in proportion as the consumption increased. As to public lighting, it was assured by contract for 24,000 francs per annum, the price of the present rudimentary lighting, and the concession of a site estimated at the letting value of 8,000 francs, for the installation of a station, which, at the end of 15 years, would become the property of the City of Paris. The Commission required certain alterations. It had heard M. Foussier, reporter of the Second Commission, on the subject, and agreed with him. It was understood that the public lighting would be paid for only by abandonment of the rent, and that, contrariwise, the works, on the expiration of the concession, would remain the property of the concessionary. At the time when this arrangement was being decided upon, M. Popp, the concessionary of the sector, intervened, and complained that a portion of his sector had been handed over to another. On this subject strict right could certainly not be invoked; the concessionary of a section might not in all cases put forward any claim if you authorised another contractor to establish himself in a portion of the sector, without having conduits to lay under the public thoroughfare. That is the case with Bercy, and it is permissible for you to give the concession to whom you will. Still the equity and interests of the City have seemed to us to require that in such cases, and at the same prices, preference should be shown to the concessionary of the sector. You know that, according to the specification, these concessionaries are obliged to serve the entire sector, which is a heavy charge, and would evidently not be accepted if the good parts were decreased by the concession of particular portions. It goes without saying that these concessions would only prevail if the concessionary of the sector accepted the same conditions as the other applicant, M. Douai. This is what has been done, and M. Popp consents to all the clauses which I have indicated, it being understood that the rent of the land handed over to M. Douai should be replaced by its value, 8,000 francs, M. Popp not requiring the land. These are, then, the conclusions which your Commission proposes to you to adopt: For public lighting, 200 10-candle lamps, giving 2,200 hours of lighting per year, will be furnished and distributed in the Bercy entrepôt, at the will of the Administration, at a fixed annual contract price of 8,000 francs. If supplementary lighting be regarded as necessary, it will be furnished at 7 centimes the hectowatt hour.

M. FOUSSIER: It is important that the streets, &c., be abundantly provided with light.

M. COCHIN (reporter): That is what will be done. As to light for tradesmen, it will be supplied to them at the prices indicated above. We have, consequently, the honour to ask you to adopt the following:—The Council resolves: Article 1. M. V. Popp is authorised to establish, in the Bercy entrepôt, electrical canalisations intended for private consumption, according to the general condition of the electricity concessions specifications, the price of these subscriptions being fixed as follows: 12 c. the hectowatt-hour delivered at the subscriber's door, while the total consumption resulting from the present concession does not exceed 1,200,000 watt-hours per day; 11 c. the hectowatt-hour when the production is between 1,200,000 and 1,800,000 watt-hours; 10 c. the hectowatt-hour when the production is between 1,800,000 and 2,400,000 watt-hours; 9 c. the hectowatt-hour when the production is between 2,400,000 and 3,000,000 watt-hours, and 8 c. over. Article 2. The tender is approved by which M. Popp undertakes, for public lighting, to feed 200 10-candle lamps burning an average of 2,200 hours per year, and placed at the will of the Administration in the streets and on the banks of the river for the contract price of 8,000 francs per year, it being understood that if the necessity to increase the public lighting arise, the surplus of consumption is to be paid for at the rate of 7 c. the hectowatt-hour. Article 3. The public light of the Bercy entrepôt must be ensured within six months as and from notification of the Administrative acceptance of the tender, under pain of forfeiture. Article 4. The security to be lodged by M. Popp as a guarantee is fixed at the sum of 500 francs. Article 5. The cost of stamp, registration, and other expenses attaching to M. Popp's tender will be payable by him. Article 6. The present authorisation will come to an end on March 1st, 1907. Article 8. These conditions

apply exclusively to the Bercy entrepôt considered as the object of a private concession.

M. GREBAUVAL: It is regrettable that we should give M. Popp an advantage over the son of General Douai.

The Commission's conclusions were then adopted, and the proceedings terminated.

THE STORY OF A STRANGE FAULT.

A FAULT in a submarine cable has been brought to our notice lately which possesses some novelty and, at the same time, brings into view some historical features. Some quantity of small sized submarine cable was purchased a good many years ago in the United States by a Lancashire gentleman who owned some collieries. This cable was stated to have been originally made in England and shipped over to America. A quantity of it was bought by the gentleman we mention and shipped to Lancashire, where it has at times been used in various lengths and for various purposes, formerly for signalling, latterly for telephones, leaving a small surplus of between one and two miles. As some electric lighting had to be done recently about the colliery and the owner's house (the original proprietor who bought this cable has been dead for some time and exact records could not be obtained), it was suggested that some of this cable could be used for a portion of the work where the wires had to be carried underground. Messrs. Mercier, Corlett & Co., of Wigan, who had the work in hand, forwarded this cable to the works of Messrs. W. T. Glover and Co., of Salford, for examination, and repair if necessary.

The cable, in two lengths, both of which were placed in water, was carefully examined and kept there for some time. One piece was found perfectly sound and tested well, giving a good insulation, whilst the other was found faulty with a "dead earth," which was easily localised.

The sound cable after being put into order for laying down, and the faulty piece, after the bad place had been cut out and the tests showed it again to be good, were sent away.

The cable was constructed with a conductor of 7/21 insulated with gutta-percha. Served with jute yarn and armoured with 18 No. 14½ wires, the fault itself showed full earth, but no disconnection, and although the test for distance was correct, no external signs could be seen to account for the fault. A piece about two yards in length, containing the fault, was cut out, and a portion of the armour taken off, so as to admit of the core being unlaid. On removing the core it suddenly came away clean cut through serving, insulation, and conductor, the division being perfectly clean and smooth, and evidently cut by a sharp instrument. On replacing the core exactly as it was originally, and then restoring the armour to its place, it was found on close examination that there was a slight opening between two wires corresponding with the cut. This was evidently caused by a fine sharp narrow chisel, or a similar tool which had been placed between the wires and driven through the core until it was stopped by the iron wires on the reverse side.

This cable, from the original statement, was purchased in England in 1861, and, believed to be made by Glass, Elliot and Company, was shipped to the United States for some special purpose. As the civil war in America broke out in that year, it is not unreasonable to suppose that this cable was employed during the war for either telegraphic, torpedo, or mining purposes, by either one side or the other, and that the special section now referred to was in operation. The damage would be probably done by one of the opposing sides, so as to effectually destroy the communication without giving any external signs that the cable was damaged. This supposition appears to be the only one to account for a fault of this character. There is no doubt but that this cable was in the United States during the time of the war. From further enquiries made, it has been ascertained that a cable of this precise type was made in 1861 by Glass, Elliot and Company, for some repairs to the Red Sea cable. This cable, about 200 miles in length, was sent out, but all came back again, and was brought to their works at Greenwich, but beyond that we have not been able to obtain definite information. However, the type of cable and its characteristics speak for themselves, and there can be no question but that it was originally made in 1861, underwent many vicissitudes in the United States, and finally returned to England, where, for many years, it remained stowed away in the works connected with a colliery. That it was used in the American War we have no absolute proof, beyond the fact that it was in the States at the time, and from the nature of the fault which was clearly malicious.

The sections to which we have referred gave good tests as to insulation, and as the thickness of the dielectric was $\frac{1}{10}$th-inch, it was considered safe to place them underground in connection with an electric light circuit. These cables are now working satisfactorily, with an alternating current of 2,000 volts.

The fault itself is now in the possession of Mr. W. H. Preece, F.R.S., at the General Post Office, having been placed in his hands by the writer, who has had in the past an extensive experience of cable faults.

THE NEW ANGLO-GERMAN CABLE.

THOUGH coming in rather a roundabout direction, we learn from a Berlin telegram, of the 8th inst., that the steamer *Faraday*, belonging to Messrs. Siemens, left Woolwich a few days ago to lay the new Anglo-German cable. Hitherto, direct telegraphic communication between England and Germany has been carried on by means of two four-conductor cables, one belonging to each nation. The number of telegrams has, during the past two years, so largely increased, that the two cables were scarcely able to deal with the messages, hence the necessity for a third.

The principal cause of the large augmentation was the reduction in the charges on April 1st, 1889. In 1879, says the *Kölnische Zeitung*, when the rate was 30 pfennigs per word, about 600,000 telegrams were despatched; but during 1889, that is, after the reduced charge of 15 pfennigs had come into operation, the number of messages advanced to 1,320,000. The development was, however, even greater when several eastern countries, and especially Austria-Hungary and the Balkan States began to despatch their telegrams for England along the German-English cables.

The negotiations which the English and the German telegraph administrations opened with a view to affording greater telegraphic facilities between the two countries were quickly brought to a satisfactory conclusion, and it was decided to lay down a new cable containing four conductors between Emden and Bacton, a little to the north of Lowestoft. The cost of the cable, which is estimated at £95,000, will be equally borne by the two administrations. Now, after a few months, the cable has been laid. It is 440 kilometres or 272·80 miles in length, and has been manufactured by Messrs. Siemens Brothers, of Woolwich. A few days ago the cable was stored on board the cable steamer *Faraday*, and the representatives of the German and English telegraph authorities embarked and the vessel proceeded to Bacton. Here, after being connected to the English telegraph lines, the laying of the deep-sea cable commenced on the 10th inst. The vessel reached Borkum on Wednesday, where the new cable was spliced with the Emden-Greetsiel-Borkum cable which was finished by the Germans on the 6th inst.

The splicing of these two cables, which took place in the presence of Dr. von Stephan, the State secretary of the Imperial post office, completed the new telegraphic communication between Germany and Great Britain. The satisfactory termination of this connection will doubtless tend to increase telegraphic messages between the two countries.

The *Kölnische Zeitung* has hitherto been one of the most bitter opponents of England, but it appears that the recent visit of the German Emperor has induced it to modify its opinion. In order to show how far this is the case, we may mention that the paper in question states that it hopes the increased facilities afforded by the new cable will augment and cement the good relations between the two countries, and also advance commercial transactions.

A NINE YEARS' RECORD OF ELECTRIC LIGHTING.

A BOARD OF TRADE report just issued gives some interesting particulars as to the provisional orders confirmed by Parliament (prior to the present session), and of the licences granted by the Board of Trade since the passing of the Electric Lighting Act of 1882. The following is a list of the provisional orders:—

1883.

Aston electric lighting order	South Staffordshire Electric Lighting Co., Ltd.	Revoked August 11, 1884
Balsall Heath electric lighting order	Do. do.	Do. do.
Barnes and Mortlake electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Do. do.
Barton, Eccles, Winton, and Monton Local Board electric lighting order	The Local Board	
Bermondsey electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Birkdale electric lighting order	The Local Board	
Birmingham electric lighting order	Incandescent Electric Lighting Co., Ltd.	Revoked Dec. 15, 1886
Bradford electric lighting order	The Corporation	
Brighton Electric lighting order	Do.	
Bristol electric lighting order	Do.	
Cambridge electric lighting order	Provincial (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Canterbury electric lighting order	South-Eastern (Brush) Electric Light and Power Co., Ltd.	Revoked May 13, 1885
Carlisle electric lighting order	The Corporation	
Chelsea electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked July 26, 1884
Chiswick electric lighting order	Do. do.	Revoked August 11, 1884
Clerkenwell electric lighting order	Do. do.	Do. do.
Croydon electric lighting order	South-Eastern (Brush) Electric Light and Power Co., Ltd.	Revoked May 13, 1885
Dudley electric lighting order	South Staffordshire Electric Lighting Co., Ltd.	Revoked August 11, 1884
Dundee electric lighting order	Brush Electric Light and Power Co. of Scotland, Ltd.	Revoked May 13, 1885
Finchley electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Folkestone electric lighting order	South-Eastern (Brush) Electric Light and Power Co., Ltd.	Do. do.
Grantham electric lighting order	The Corporation	
Gravesend electric lighting order	South-Eastern (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Greenock electric lighting order	The Board of Police	
Greenwich electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Hackney electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Hampstead electric lighting order	Ferranti-Hammond Electric Light Co. of Hampstead, Ltd.	Revoked May 13, 1885
Hanover Square District (London) electric lighting order	Swan United Electric Light Co., Ltd.	Do. do.
High Wycombe electric lighting order	Provincial (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Holborn electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Do. do.
Hornsey electric lighting order	Do. do.	Do. do.
Ipswich electric lighting order	Provincial (Brush) Electric Light and Power Co., Ltd.	Revoked May 13, 1885
Islington electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Limehouse electric lighting order	Do. do.	Do. do.
Lowestoft electric lighting order	Provincial (Brush) Electric Light and Power Co., Ltd.	Do. do.
Luton electric lighting order	Do. do.	Do. do.
Maidstone electric lighting order	South-Eastern (Brush) Electric Light and Power Co., Ltd.	Revoked May 13, 1885
Margate electric lighting order	Do. do.	Do. do.
Nelson electric lighting order	The Local Board	
Norwich electric lighting order	The Corporation	
Poplar electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Redditch electric lighting order	Incandescent Electric Lighting Co., Ltd.	Revoked June 30, 1885
Richmond (Surrey) electric lighting order	The Vestry	
Rochester electric lighting order	South-Eastern (Brush) Electric Light and Power Co., Ltd.	Revoked May 13, 1885
Rotherhithe electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
St. George the Martyr Southwark electric lighting order	Do. do.	Do. do.
St. George's-in-the-East electric lighting order	Do. do.	Do. do.
St. Giles' (Brush) electric lighting order	Do. do.	Do. do.
St. Giles' (Pilsen Joel) electric lighting order	Pilsen Joel and General Electric Light Co., Ltd.	Revoked August 11, 1884
St. James' and St. Martin's (London) electric lighting order	Edison Electric Light Co., Ltd.	Revoked May 13, 1885
St. Luke's electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
St. Olave electric lighting order	Do. do.	Do. do.
St. Pancras (Middlesex) electric lighting order	The Vestry	
St. Saviour's (Southwark) electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Saltley electric lighting order	South Staffordshire Electric Lighting Co., Ltd.	Revoked August 11, 1884
Scarborough electric lighting order	The Corporation	Repealed by Scarborough Corporation electric lighting order, 1891
Shoreditch electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
South Kensington electric lighting order	Swan United Electric Light Co., Ltd.	Do. do.
Strand District (London) electric lighting order	Do. do.	Revoked May 13, 1885
Sudbury electric lighting order	Provincial (Brush) Electric Light and Power Co., Ltd.	Do. do.
Sunderland electric lighting order	North-Eastern Electric Light and Power Co., Ltd.	Do. do.
Ulverston electric lighting order	The Local Board	
Victoria District (London) electric lighting order	Swan United Electric Light Co., Ltd.	Revoked May 13, 1885.
Walsall electric lighting order	Incandescent Electric Lighting Co., Ltd.	Revoked June 30, 1885
Wandsworth electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Revoked August 11, 1884
Wednesbury and Darlaston electric lighting order	South Staffordshire Electric Lighting Co., Ltd.	Do. do.
West Bromwich electric lighting order	Do. do.	Do. do.
Whitechapel electric lighting order	Metropolitan (Brush) Electric Light and Power Co., Ltd.	Do. do.
Wolverhampton electric lighting order	South Staffordshire Electric Lighting Co., Ltd.	Revoked July 29, 1884

1884.

Bury St. Edmund's electric lighting order	The Corporation	
Edison and Swan United electric lighting order	Edison and Swan United Electric Light Co., Ltd.	

This order authorised the transfer to the Edison and Swan United Electric Light Company, Limited, of the powers, &c., granted by the following orders, viz.:—St. James's and St. Martin's (London) electric lighting order, 1883. Hanover Square District (London) electric lighting order, 1883. South Kensington electric lighting order, 1883. Strand District (London) electric lighting order, 1883. Victoria District (London) electric lighting order, 1883. These orders have since been revoked (see above.)

Fulham District electrict lighting order	West Middlesex Electric Lighting Co., Ltd.	Revoked October 18, 1889
St. James, St. Martin, and St. George, Hanover Square (West London) electric lighting order	West London Electric Lighting Co., Ltd.	Revoked February 4, 1887

1886.

Chelsea electric lighting order	Chelsea Electricity Supply Co., Ltd.

1889.

Birmingham Electric Light and Power order	Messrs. Arthur Chamberlain and George Hookham
House to House Electric Light Supply order	House to House Electric Light Supply Co., Ltd.
Kensington & Knightsbridge electric lighting order	Kensington and Knightsbridge Electric Lighting Co., Ltd.
Liverpool electric lighting order	Liverpool Electric Supply Co., Ltd.
London Electric Supply Corporation electric lighting order	London Electric Supply Corporation, Ltd.
Metropolitan Electric Supply Co. (Mid London) lighting order	Metropolitan Electric Supply Co., Ltd.
Metropolitan Electric Supply Co. (West London) lighting order	Do. do.
Notting Hill electric lighting order	Notting Hill Electric Lighting Co., Ltd.
St. Martin electric light ing order	The Electricity Supply Corporation, Ltd.
South Kensington electric lighting order	Chelsea Electricity Supply Co., Ltd.
Swansea electric lighting order	The Corporation
Westminster electric lighting order	Westminster Electric Supply Corporation, Ltd.

1890.

Aberdeen electric lighting order	The Corporation
Accrington electric lighting order	Do.
Ashton-under-Lyne Electric Light and Power order	Municipal Electric Light and Power Corporation, Ltd.
Ayr Burgh electric lighting order	The Corporation
Bacup electric lighting order	Do.
Barnsley electric lighting order	Do.

Bedford electric lighting order	The Corporation	
Belfast electric lighting order	Do.	
Birkenhead electric lighting order	Do.	
Blackburn electric lighting order	Do.	
Blackpool electric lighting order	Do.	
Bognor electric lighting order	The Electric Trust, Ltd.	
Bournemouth Electric Supply (Brush) order	Brush Electrical Engineering Co., Ltd.	
Bournemouth Electric Supply (House to House) order	South of England House to House Electricity Co., Ltd.	
Burnley electric lighting order	The Corporation	
Burton-on-Trent electric lighting order	Do.	
Bury electric lighting order	The Corporation	
Cambridge electric lighting order	Do.	
Chatham, Rochester, and District electric lighting order	Chatham, Rochester, and District Electric Lighting Co., Ltd.	
Cheltenham electric lighting order	The Corporation	
Chester electric lighting order	Do.	
Coatbridge electric supply order	Scottish House-to-House Electricity Co., Ltd.	
Darlington electric lighting order	The Corporation	
Derby Corporation electric lighting order	Do.	
Dover electric lighting order	Do.	
Dundee electric lighting order	The Gas Commissioners	
Eastbourne electric supply order	Eastbourne Electric Light Co., Ltd.	
Fleetwood electric lighting order	The Improvement Commissioners	
Galway electric lighting order	John Perry, James Perry, and Jas. Edward Pearce, trading as the Galway Electric Co.	
Glasgow Corporation electric lighting order	The Corporation	
Great Yarmouth electric lighting order	Do.	
Hastings & St. Leonards-on-Sea electric supply order	Hastings and St. Leonards-on-Sea Electric Light Co., Ltd.	
Hastings (Public Purposes) electric lighting order	The Corporation	
Hove electric lighting order	The Hove Commissioners	
Huddersfield electric lighting order	The Corporation	
Kelvinside electric lighting order	Kelvinside Electricity Co., Ltd.	
Kingston-upon-Hull electric lighting order	The Corporation	
Lancaster electric lighting order	Do.	
Leicester electric lighting order	Do.	
City of London electric lighting (Brush) order	Brush Electrical Engineering Co., Ltd.	
City of London (East District) electric lighting order	Laing, Wharton and Down Construction Syndicate, Ltd.	
Crystal Palace and District electric lighting order	Electric Installation and Maintenance Co., Ltd.	
Lambeth electric supply order	House-to-House Electric Light Supply Co., Ltd.	
London electric supply corporation electric lighting (Metropolitan) order	London Electric Supply Corporation, Ltd.	
Metropolitan Electric Supply Co. (Paddington) lighting order	Metropolitan Electric Supply Co., Ltd.	
North London electric supply order	House-to-House Electric Light Supply Co., Ltd.	
St. James's electric lighting order	St. James's and Pall Mall Electric Light Co., Ltd.	
Wandsworth District electric supply order	House-to-House Electric Light Supply Co., Ltd.	
Malvern electric lighting order	The Local Board	
Manchester electric lighting order	The Corporation	
Morecambe electric light and power order	Messrs. Thomas Reginald Andrews and Thomas Preece	
Moss Side and Stretford electric lighting order	Manchester House-to-House Electricity Co., Ltd.	
Northampton electric lighting order	Northampton Electric Light and Power Co., Ltd.	
Nottingham electric lighting order	The Corporation	
Oldham electric lighting order	Do.	
Oxford electric lighting order	Electric Installation and Maintenance Co., Ltd.	
Plymouth electric lighting order	Devon and Cornwall Electricity Supply Co., Ltd.	
Portsmouth electric lighting order	The Corporation	
Preston electric lighting order	National Electric Supply Co., Ltd.	Repealed by Preston electric lighting order, 1891
Preston and Fulwood electric lighting order	Lancashire and Cheshire House-to-House Electricity Co., Ltd.	Revoked June 10, 1891
Salford electric lighting order	The Corporation	
Sevenoaks electric lighting order	The Electric Trust, Ltd.	
Stafford electric lighting order	The Corporation	
Stockton-on-Tees electric lighting order	Do.	
Tiverton electric lighting order	The Corporation	
Tunstall electric lighting order	The Electric Trust, Ltd.	
Walsall electric lighting order	The Corporation	
Wigan electric lighting order	Do.	
Windsor electric supply order	Windsor and Eton Electric Light Co., Ltd.	
Woking Electric Supply Co. order	Woking Electric Supply Co., Ltd.	
Wolverhampton electric lighting order	The Corporation	
Worcester electric lighting order	Do.	
Wrexham electric light and power order	Wrexham and District Electric Supply Co., Ltd.	
York electric lighting order	The Corporation	

The following are the licences granted:—

1884.

Colchester electric lighting licence	South-Eastern (Brush) Electric Light and Power Co., Ltd.	

1885.

Dalton-in-Furness electric lighting licence	The Local Board	
St. Austell electric lighting licence	John Edward Veale	

1886.

Dundalk electric lighting licence	The Town Commissioners	

1887.

Kensington Court electric lighting licence	Kensington Court Electric Lighting Co., Ltd.	Repealed by the Kensington and Knightsbridge electric lighting order, 1889

1888.

Kensington Court electric lighting licence	Kensington Court Electric Lighting Co., Ltd.	Do. do.
Liverpool electric lighting licence	Liverpool Electric Supply Co., Ltd.	Repealed by the Liverpool electric lighting order, 1889
St. James's electric lighting licence	St. James's and Pall Mall Electric Light Co., Ltd.	Repealed by the St. James's electric lighting order, 1890

1889.

Dublin electric lighting licence (public)	The Corporation	
Kensington electric lighting licence	Kensington Court Electric Lighting Co., Ltd.	Repealed by the Kensington and Knightsbridge electric lighting order, 1889
Wimbledon electric lighting licence	The Local Board	

1890.

Bath electric lighting licence	Henry George Massingham	
Chelmsford electric lighting licence	Crompton & Co., Ltd.	
Dublin Electric lighting licence (private)	The Corporation	
Newcastle and District Electric Lighting Company's licence	Newcastle and District Electric Light Co., Ltd.	The Newcastle-upon-Tyne electric lighting order, 1891, now before Parliament, contains a provision for the repeal of this licence
Newcastle-upon-Tyne Electric Supply Company's licence	Newcastle-upon-Tyne Electric Supply Co., Ltd.	
Northampton electric lighting licence	Northampton Electric Light and Power Co., Ltd.	Repealed by the Northampton electric lighting order, 1890
Southampton electric lighting licence	Southampton Electric Light and Power Co., Ltd.	

LEGAL.

Liverpool Electric Supply Company v. Saydi's Challenge Remedies Company.—At the Nisi Prius Court of the Liverpool Assizes, on Saturday, 1st inst., before Mr. Justice Wright and a special jury, the case of the Liverpool Electric Supply Company, Limited *v.* Saydi's Challenge Remedies Company and Edwin Morris, which was a claim for breach of contract, came on for hearing. Mr. Bigham, Q.C., and Mr. Taylor were for the plaintiff company; Mr. Kennedy, Q.C., and Mr. Horridge for the Saydi's Company; and Mr. Pickford for the defendant Morris.

Mr. BIGHAM said this was an action to recover the cost of installing electric light in some premises in Byrom Street, Liverpool, where the business of the Saydi's Challenge Remedies Company, whatever it was, was carried on. The Saydi's Company pleaded that the installation was not put up within the contract time, and Mr. Edwin Morris, who was a solicitor, pleaded the same thing, and in addition said he had no connection with the Saydi's Company, and was not liable for its debts.

His LORDSHIP asked how it was a defence to the action that the things were not put up in time.

Mr. BIGHAM said that the defence was that the company undertook to put up the installation as soon as possible, and that that was not done, and he supposed that it was alleged that that was a ground for the diminution of the costs, or a set-off, or counter-claim—that that was a condition, and, therefore, it was an answer to the claim.

His LORDSHIP said he could not understand that, unless the time was specified in the contract.

Mr. KENNEDY said that on the correspondence he contended that all possible despatch should have been used in putting up the installation, and the question is whether such despatch was used.

His LORDSHIP said there was no such case on the pleadings.

Mr. BIGHAM said that the odd part of it was that the work had been done, and Mr. Morris or the Challenge Remedies Company was now in a position by statute to require the Electric Supply Company to turn on the light at any moment; and while he could do that he said, "You were too long in installing it, and so I will not pay for it." The facts were that at the beginning of 1890 somebody discovered certain patent or secret pills, and it was thought, as far as he could make out, by Mr. Edwin Morris, that it would be a profitable business to carry on in Byrom Street, Liverpool. On the 1st May, 1890, Morris wrote to the Electric Supply Company to have electric light put in the premises in Byrom Street, and after negotiations a contract was accepted on the 23rd May, 1890, to put in the installation and erect two advertising lamps outside for £63 13s., the amount now claimed. The plaintiffs had expressed the opinion that the installation would be fitted up in 12 weeks, but had declined to bind themselves to any specified time.

In answer to his Lordship, Mr. KENNEDY then said that his contention on the correspondence was that the whole work had not been completed as quickly as possible, as plaintiffs had contracted. After waiting until the 26th of February his clients, finding that they had got nothing, had to put in gas in the premises, and gave notice to the plaintiffs to cancel the contract. It was true that the fittings on the premises had been put in, but the mains in the street had not been laid.

His LORDSHIP said there was no total failure of consideration, nor was the work stopped.

Mr. KENNEDY said that was one complete job; there was no use having a lot of ornamental fittings without a supply of light. In law it was implied that there should be a reasonable time.

His LORDSHIP: It is very likely you are entitled to damages, but not on these pleadings. Subsequently, his Lordship said he supposed the fittings were worth the full amount charged, though the jury might cut down the claim on the ground that the delay made them less valuable.

In answer to a juror,

Mr. BIGHAM said that some difficulty had been experienced in getting the permission of the corporation to lay the mains, but on December 18th they were completed and ready to be connected. The work of installation which was now sued for was finished in July.

Mr. KENNEDY said he did not agree that there were two contracts; there was only one.

His LORDSHIP: How does the contract to put up the installation depend upon the connection?

Mr. KENNEDY argued the whole thing must be treated as one—because one would be useless without the other.

Mr. BIGHAM contended there were two contracts—one for the installation and the other to supply the electric light.

His LORDSHIP expressed the opinion that there was not total failure of consideration, and said that in his view all Mr. Bigham had to do was to prove Morris's liability.

His LORDSHIP refused to allow Mr. Kennedy to amend the pleadings, as he considered no injustice was involved, the plaintiffs having proceeded with the work as quickly as they were allowed. The questions he put to the jury were whether the fittings had become valueless, and whether the defendant Morris was connected with the company.

The jury found for the plaintiffs for the full amount against both defendants.

Judgment was given accordingly with costs, and with reserved costs against Morris personally.

REVIEWS.

Dynamo Construction: A Practical Handbook. By JOHN W. URQUHART. London: Crosby Lockwood & Son.

Mr. Urquhart writes for the electrical masses and this work of his furnishes them with a fairly harmless mixture of all sorts of odd notes culled from electrical journals, proceedings of societies, and periodicals of various kinds. We fail to discover any method in the book, and the "ordinary engineers and mechanics" who read it for information deserve our pity, for they will have to do a lot of reading to little purpose. One thing is certain, Mr. Urquhart's book will never teach one how to construct dynamos, and that the author is ignorant of the best and most recent papers published on the subject, is evident from his adopting antiquated notions throughout. The wording is loose and the treatment wholly unscientific, while the notions are frequently of the crudest character, and abounding in inaccuracy. The author's remarks regarding divided magnets on page 82 are based on a misconception, and his explanation of the cause of sparking, on page 131, is erroneous. The winding of the field magnets is wrongly shown in fig. 25, as also that of the coils in figs. 38 and 102. Fig. 33 is drawn in such manner that the commutation of current takes place at the wrong position. On page 95 we meet the funny expression, "inducement of a current," and farther down the same page the author shows that, like many more, he fails to see that there is essentially no difference between an armature having an iron core and one having none. On page 160 he tells us that sixteen sections is a very common number for drum wound armatures, and it certainly was—10 years ago. There is little definiteness, the statements being mostly of a vague character, such as "dynamo builders are generally in agreement in allowing from 1,000 to 2,000 amperes per square inch sectional area of conductor," and so on, though the one redeeming feature of the book, namely, a host of good illustrations, all printed from specially cut blocks, should receive favourable mention. As we said before, the book is nearly harmless, for though it cannot in our opinion be in any sense regarded as a treatise on dynamo construction, we have no hesition in recommending it as an enlarged dynamo tender's book.

The "Electrician" Primers. Vol. I.: Theory. Vol. II.: Practice. London: The *Electrician* Printing and Publishing Company, Salisbury Court, Fleet Street.

These two volumes are made up of a series of 38 short articles of one or two pages each. The articles are stated to be written by "well-known writers." It is somewhat unfortunate that at almost the commencement of the first volume we should come across a rather absurd mistake, viz., in Primer 2 ("Conductors and Insulators"), page 5, we are told fig. 2 represents Latimer Clark's double-cup form of insulator . . .; as a matter of fact, the illustration given is that of Messrs. Johnson and Phillips's oil insulator, and has no resemblance to the ordinary double-cup referred to. The articles are generally so well written and the subject matter so judiciously condensed that there is but very little to criticise though much to praise. At the same time, we think that here and there expressions are introduced which to a general reader would be incomprehensible. Thus, in the primer last referred to (No. 2), the reader is informed that the insulation of a particular insulator is 60,000 *megohms*, whilst there is no explanation of what a megohm is. Probably it would have been preferable if the primer on "units" formed one of the first, instead of being No. 10. In primer 21, on Telegraphy, it is hardly correct to speak of the "single-needle instrument" as being "the same in principle" as the Morse.

An Arithmetic of Electricity. By T. O'CONOR SLOANE. New York: N. W. Henley & Co. London: E. & F. N. Spon.

Although there are now a good many works of this kind, we should not be inclined to say that there are too many. Books of fully worked out examples are of particular value to learners, they impress information and explain it in a way which no formulæ pure and simple can do. The book does not deal with matters beyond the elementary range; magnetic fields and lines of force are, however, considered. A few useful tables conclude the work.

Journal of the Institution of Electrical Engineers. No. 94. Vol. XX. London: E. & F. N. Spon.

The principal contents of this number are as follows:—Papers on "Some Effects of Alternating-Current Flow in Circuits having Capacity and Self-Induction," by Dr. J. A. Fleming. "Some Points Connected with Mains for Electric Lighting," by W. H. Preece. "The Most Economical Method of Feeding a Low-Pressure Network." By R. E. Crompton.

Provisional Order for Lynton.—At a meeting of the Lynton Local Board recently, notice was given that the Devon Electric Lighting Company intends applying to the Board of Trade in November for a provisional order to supply the electric light to Lynton and Lynmouth.

NOTES.

Electric Motors.—The Compagnie d'Orléans has adopted electric motors for the handling of the wines in its cellars at Vitry. It has also introduced in its Paris works a motor for driving a linen washing drum.

The Channel Cables.—The telegraph cable between Dover and Boulogne is to be relaid, and a change made in the course it takes across the Channel, it having been deemed advisable, in consequence of the injury so frequently done to the cable at the base of the Shakespeare Cliffs, to take the cable on to Folkestone.

Electric Lighting at Aranjuez, Madrid.—A wealthy capitalist at Aranjuez has recently had an electric central station at a flour mill. Water power to the extent of 180 H.P. is utilised. For the public lighting of the streets 31 arc lights are used, and 600 private lamps are already subscribed for. Three Siemens dynamos of the four-pole type are ready for use, but only one is needed at present.

Electric Lighting at Kingswood.—Messrs. Parfitt, whom the Local Board have instructed to instal the electric light, are procuring a site of about half an acre for erecting the powerful twin engines, the two large boilers, and the dynamos. The firm intend having the district lighted in about four months.

Aberdeen Trades Council Exhibition.—The committee of this exhibition, which was to be held in December, held a meeting last week, when the question of electric lighting was discussed. Nothing definite was resolved, except that an estimate of the probable cost of the undertaking be sent in on an early date by Messrs. Macwhirter & Co., electricians, Glasgow, whose representative was present at the meeting.

Eastbourne Lighting.—Lately the electric lighting company have extended their business, but so far the gas company has not suffered in consequence. There is a proposal to reduce the charge for gas again at the next half-yearly meeting. The public is at present paying 3s. 4d., but if the price of electric light is reduced very considerably, there is no doubt that the gas concern would have less bright prospects than it has at present.

New Swiss Cable Railway.—The water power of Buochs, which is already used for working the Burgenstock Railway, is about to be employed in operating a cable line on the Stanserhorn. The water will actuate a turbine and dynamo, the current from the latter to be transmitted just over three miles to the three electric motors which will work the cable railway. The line will be nearly two miles long, and will be divided into three sections, each of which will be independent, and will be worked by a motor of 50 H.P.

Electric Light Supports in Brussels.—*Apropos* of the question of the electric light masts on the Grand Place, the *Indépendence Belge* says :—At the present moment there is being studied in the offices of the Hôtel de Ville an unquestionably original project for the electric lighting of the place which would get over the architectural and other objections which are raised to the suggestions for masts which have been sent to the special committee. The system submitted for examination by the electricity service consists of masts formed of high steel rods which would be drawn at nightfall from sheaths placed in the ground, and which would be drawn back again at daybreak, so as to in no way alter the architectural appearance of the Grand'Place during the daytime. It is proposed to work these movable masts by means of hydraulic pressure.

Rochester and Chatham Electric Light Company's Works.—The new works of the Rochester and Chatham Electric Lighting Company are satisfactorily proceeding. New boilers have been fixed, and the engine which was used in supplying the electric current to the Edinburgh Exhibition has been purchased.

Gas v. Electric Light.—The following letter has been addressed to the editor of the *Pall Mall Gazette* :—"The experience I have had of the cost of electric lights, now for two years past, does not accord with the statements and figures supplied by Mr. Preece. When I had the electric light laid on first the company handed me a circular, in which they stated their charge would be 20s. per annum for 8-candle lamps, to be used not over an average of three hours per day. Shortly after this they declined to supply the light at a fixed charge at all, and required a meter to be used. With this the result of something under 100 lamps has been a cost of over 10s. per lamp for each of the winter quarters and about 7s. 6d. for the summer quarters, or 35s. per annum for 8-candle incandescent lamps. If Mr. Preece's statement is correct that 10s. per annum is the usual price per lamp, why do the electric companies refuse to supply at double that figure? Further, what becomes of the theory of 8s. 4d. per lamp per annum for private dwellings, where in winter they would be required six or eight hours per day? I shall be glad to show my accounts to Mr. Preece or any member of his audience or any other person interested in the matter."

Barnet Lighting.—The Barnet Local Board has stuck to its resolution, and affixed its seal to contract with the Barnet Gas and Water Company for lighting the streets of the town with gas for a term of three years, commencing September 1st. We have always held that incandescent lamps for the purpose were a mistake, and we trust that Messrs. Joel will keep clear of street lighting by this means for the future. It is evident, however, that we have not heard the last of this unfortunate bungle. for the old method of lighting of the Barnet streets with gas is not to be allowed to commence without opposition. Those who desired the retention of the electric light argue that the meeting at which the gas contract was signed was null and void, in consequence of some informalities, and there appears to be a fair prospect of lively times in store for the advocates of the rival luminants on the Local Board, to say nothing of possible costly complications for the ratepayers. Meanwhile the long expected statement of the claims made by Messrs. Joel, the contractors for the recent electric lighting, has been delivered. Under one series of claims, the firm asks for upwards of £5,250, and under an alternative series, upwards of £5,750 is claimed.

The Mechanical Equivalent of Heat.—A note has been received by the Paris Académie des Sciences from M. Constantin Miculesco on a new determination of the mechanical equivalent of heat. The principle of the method was the same as Joule's, viz., the production of heat in a calorimeter by means of friction. The whole of the work done by Joule's experiments, however, was small, and hence a good time was required to obtain a sensible heating of the calorimeter, and some difficult corrections had to be made. To prevent this, M. Miculesco used a fairly powerful electromotor to supply the work which was to be turned into heat. The apparatus comprised a 1 horse-power Gramme electromotor, carried on a frame suspended on knife edges, the motor-shaft being central with the line of these supports. On a separate frame was mounted a calorimeter consisting of two concentric cylinders, so that the axes of the cylinders coincided with the centre line of the motor shaft. By means of a flexible connection this shaft was coupled to one bearing paddles, which it caused to revolve in the water in the cylinders. Under such circumstances the frame carrying the motor tended to swing on its knife edges in order to balance the torque on the motor shaft, and by correcting this tendency by carefully adding weights, this torque could be measured with great accuracy. The result obtained was **J = 777·7 foot-pounds.**

Portuguese Import Duties.—It is reported that the Portuguese import duty on telephone and telegraph materials, which is at present 25 reis per kilo, will be considerably increased in 1892.

The New Anglo-German Cable.—We learn, just as we go to press, that messages have been transmitted through the new cable to which we have alluded on page 188.

Ambleside Electric Lighting.—The owners of the electric boats on Windermere have prepared estimates for the lighting of Ambleside with electricity. The installation would cost £2,000, and working expenses £200 a year. The matter is to be considered at the next meeting of the Local Board.

Johannesburg Gas and Electricity.—At a meeting of the Johannesburg Gas Company, held on Wednesday last, it was resolved: "That a new company, to be called the Johannesburg Lighting Company, be formed for the purpose of working concessions for lighting Johannesburg with gas and electricity respectively."

Electrical Boring Machine.—A short paragraph appeared in our last issue relating to an electrical boring drill, in connection with the Manchester sewage scheme. We are informed that this was supplied by Messrs. Charlesworth, Hall & Co., of Oldham. The electrical plant consists of dynamo and motor of 12 H.P. at 400 revolutions, and capable of giving double that power at 800 revolutions.

Swinburne and Company.—Messrs. Swinburne & Co.'s staff, workmen and *employés*, had their first annual outing on Friday. They went in a steam launch from Staines to Windsor, where they dined. They then came down to Savory's Weir for tea, and returned to Teddington in the evening, spending a pleasant day, in spite of occasional showers. It is not stated how the "hedgehogs" comported themselves.

Crystal Palace School of Engineering.—The award of certificates took place on Saturday last, in the newly-erected lecture theatre of the School of Practical Engineering at the Crystal Palace. Sir Guilford Molesworth presided, and gave some valuable hints to the students on a number of points affecting their prospects in the profession. Before the close of the proceedings Mr. Samuel Green, director, took occasion to suggest the formation of a society of old students, a proposition that was well received.

Liverpool Overhead Railway.—Sir W. Forwood, presiding on the 11th inst., at the half-yearly meeting of the Liverpool Overhead Railway Company, announced that satisfactory progress had been made with the line, and that a contract had been made for its electrical equipment with the Electric Construction Corporation, Limited, London and Wolverhampton, who will work the line for two years at 3½d. per train mile for locomotive expenses. Two miles had been completed within the last six months, and the railway would probably be at work next Spring.

Tesla's "Idiomatic Statements."—We notice *Industries* is protesting against Mr. Tesla's habit of advancing as theories or explanations of phenomena, which are either rational theories made inexplicit by strange expressions or simply lists of words deficient of meaning. We have no desire, says our contemporary, to pick out weak points in such an interesting lecture, but we think that any one who read Mr. Tesla's articles must have had great difficulty in understanding his repeated idiomatic statements. Is it asking Mr. Tesla too much, holding the prominent position he does in the American electrical world, when we say we think if he omitted some of the confusing passages his lectures would be much better understood, and if he would keep ideas anent electro-magnetic theory of light, also Hertz and Dr. Lodge, from his work, his experiments would be clearer as well as more interesting. We hope Mr. Tesla is correct when he surmises that the future light may be produced by vacuum tubes; but we believe the subject has been thoroughly searched out ere this by many inventors without a result which has been very promising.

A Strange Rumour.—At the time of going to press a strange and startling rumour is in the air, to the effect that Mr. Ferranti has severed his connection with the London Electric Supply Corporation and left the country. We cannot, however, vouch for the truth of this.

Storage Battery Patents.—Over 800 patents have been granted by the United States Patent Office on storage batteries and their details.

County Council v. City and South London Railway.—Regarding the decision of the High Courts in favour of the City and South London Railway, on Friday last, the London County Council succeeded in getting £200 deducted from their opponents' bill of costs.

Electric Light at Maidstone.—At a private meeting of the Maidstone Local Board on Tuesday morning the question of supplying the town by electricity was considered, and it was resolved to apply to the Board of Trade for a provisional order, and also, if possible, to put their rights into the hands of an electric lighting company.

Taunton Exhibition Catalogue.—The catalogue of the present Taunton Electrical Exhibition and the large coloured posters are very good specimens of wooden printing. The printers, Messrs. E. Goodman and Son, of Taunton, are looked upon as one of the most enterprising firms in the provinces, and have a reputation for the production of new and effective designs in typography.

The Old Students' Association.—The hon. sec. of this association writes to us as follows:—"Will you kindly give us a notice of the enclosed, respecting the garden party to be held by the O.S.A. on September 5th." We have searched in vain for the enclosure; but, alas! as is the case with the worthy secretary himself sometimes when wanted, it is not to be found.

Dublin Gaiety Theatre Lit by Electricity.—During the summer recess this theatre has been entirely altered and improved. The electric lighting arrangements have been carried out by the Electrical Engineering Company of Ireland, under the supervision of Mr. Harry South, who has introdueed several of his patent stage appliances and special methods of working. The plant for developing the current consists of a pair of Otto gas engines of 14 horse-power each. driving two compound wound dynamo-electric machines, The auditorium, corridors, saloon, and the footlights, are the sections into which the house is divided. The whole work has been executed in a way which reflects the highest credit upon all concerned in it. There are some 250 lamps fixed, and they cause a vast improvement in the building.

City and South London Railway.—A representative of the *Daily Oracle* has interviewed an official of the South London Railway on the prospects of the company, and though it has resulted in a column of print, it really contains nothing which throws light upon the prospects of the company. Nor can it be said that the chairman did much to enlighten the shareholders at the general meeting held on Tuesday. It is easy to indulge in comparative statements, but it is most dangerous to the hopes of the proprietors. The profit per mile on the North Western and other great lines has no bearing whatever on so small a line as the South London. Where, we venture to ask, would be the profit on the London and North Western if their line extended, say, to Harrow, or some other small place. The chairman was scarcely wise in giving figures from other railways, for there is nothing in the least degree in common with the electric line—in fact, no more than that existing between a great railway company and a line of omnibuses. It is evidently not the intention of the directors to do anything at present with the Clapham extension; perhaps this is wise, but as matters stand, it will be necessary to crowd a good many more passengers into the trains before a respectable dividend is earned. The chairman spoke of the electrical difficulties they had overcome; it may be said that the electrical portion of the undertaking has been, and will prove to be, the least troublesome feature of the whole concern.

The Press and the Executions by Electricity.—A New York telegram says:—"The Grand Jury has indicted the following papers for publishing detailed reports of the recent executions by electricity at Sing-Sing:—The *Journal*, *Press*, *Times*, *Sun*, *World*, *Recorder*, and *Advertiser*."

An Electrical Testing Station for Vienna.—A building is at present in course of construction which is intended to be used as an electrical testing station in connection with the electrical department of the Technological Gewerbe-Museum in the Währingerstrasse.

A New Use for Aluminium.—It is reported that a new use has been found for aluminium. It is proposed to use it in place of magnesium for photographic flash lights. A mixture of powdered aluminium and chlorate of potash gives a brilliant flash without the smoke produced by magnesium, which is in itself an advantage.

Oxford and the Electric Light.—Regarding the provisional order granted some time ago to the Electric Installation and Maintenance Company, Limited, plans have been presented to the General Purposes Committee of the Corporation, and were brought before the council on 5th inst. It is very probable that ere long considerable progress will be made with the work.

Electric Traction at Darlaston.—At a meeting of the Local Board held last week, under the presidency of Mr. E. Horton, the clerk reported that the South Staffordshire Tramway Company had repeated their application for the board to sanction a system of electric traction by means of overhead wires in the parish of Darlaston, Walsall and Wednesbury having consented, and it was decided that, subject to a proper agreement, the necessary consent be accorded.

The Proposed Crystal Palace Electrical Exhibition.—At the meeting of the London Chamber of Commerce last Friday the following resolutions were passed:—1. That in the opinion of this meeting the offer of the Crystal Palace Company to postpone the opening of the Exhibition to January 1st will afford a compromising time which is not entirely satisfactory to the electrical trades, but in view of the fixed determination of the directors to hold the exhibition, this meeting advises the electrical trades to support the thing as far as possible. 2. But this meeting strongly urges that the prospects of the success of the exhibition would be greatly improved if the Crystal Palace directors see their way to still further postpone the exhibition until November 1st, 1892, which would appear to be a very favourable date for holding the exhibition.

American Edison Incandescent Lamp Case.—The injunction which was granted to Edison by Judge Wallace has been stayed for six months, pending the appeal to the United States Circuit Court of appeals. The United States Company have to give a bond for $50,000, ten days being allowed in which to execute it. The Courts, in granting the stay, thought that the action for infringement should have been brought earlier, before the defendants had invested largely, and that in this particular patent the wording was well calculated to engender doubt in the minds of people as to whether it was good for anything. The infringer could not be blamed for assuming that he could go on and make any kind of incandescent lamp without fear of the patent. No two judges who had had the patent before them had ever agreed upon it. The Court, therefore, in view of the fact that the case was not brought for five years, and in view of the doubt whether the decision will be upheld, and also looking to the fact of the large investment that has been made by those who probably thought they could safely make the lamps, and to the great disturbance of labour that would ensue from closing factories, considered itself justified in exercising its authority in suspending the operation of the injunction.

Wealthy Electricians.—It is said that no scientific body in the United States has so many millionaires as the American Institute of Electrical Engineers.

Theatre Lighting.—The Theatre Royal, Newcastle, has now been opened after being entirely re-painted and re-decorated. Amongst other improvements the electric light has been introduced.

Proposed Electric Lighting of Belfast.—At a meeting of the committee of the Belfast City Council it was reported that a sub-committee had made full enquiry respecting the electric light and the providing of an installation for a district of the city. The mayor said that though the committee had fully discharged their duties, they had not been able to get proper data as to the cost. He pointed out that in any event the gas works would, at least for a time, require to be extended.

Dundee Lighting.—A special committee of the Dundee Gas Commission have been considering the question of electric lighting. It was proposed that Messrs. Brownlee and Mitchell, taking any assistance they consider proper, should visit such works as are already in existence in English places similar to Dundee, and report thereon, and also as to the best system to adopt for Dundee. They are also to report as to what works in their opinion should be provided, if there should be a central station, and as to a site for such a station.

An Electrical Transformer for Surgical, Medical and Dental Purposes.—In the last number of the *Lancet* appears an illustrated description of an electrical transformer for surgical, medical and dental purposes, which has been designed by A. B. Woakes, M.R.C.S., L.R.C.P., London, and made by K. Schall, of 53, Wigmore Street, London, W. In the transformer there are three pairs of terminals, the first for supplying current to the electrical cautery, the second for illuminating a surgical incandescent lamp, and the third supplying "Faradaic" shocks, so that in one instrument the surgeon has at his command electricity for any of these three purposes. For the purposes of the cautery a maximum current of 20 ampères at 6 volts can be obtained.

NEW COMPANIES REGISTERED.

Field's "M.P." Development Association, Limited.—Capital, £100,000 in £1 shares. Objects: To purchase, take over, and work patents to the number of 49, granted, or applied for and not yet issued, in the following countries, viz.: Great Britain (5), Belgium (3), Austria (2), Brazil (2), Canada (2), Italy (2), France (3), Germany (2), Luxemburg (2), New South Wales (2), New Zealand (2), United States (4), Queensland (2), South Australia (2), Spain (2), Switzerland (2), Denmark (2), India (2), Victoria (2), Norway (2), and Sweden (2); to carry on, either as principals or agents, the business of engineers, manufacturers of, and dealers in engines, boilers, motors, iron, steel, copper, and other metals; merchants, bankers, brokers, shippers, agents, carriers and contractors; and to carry on the business of electric light in all its branches, by constructing, laying down, fixing, and carrying all necessary cables, wires, lines, accumulators, lamps, and works for the generation, distribution and supply of electricity. Signatories (with one share each): G. E. Wilkinson, 25, Gladsmore Road, Stamford Hill, N.; J. London, The Poplars, Latimer Road, Forest Gate, Essex; G. F. Smith, 91, Brunswick Street, Hackney Road, N.E.; A. Crispin, 25, Bromley Street, Commercial Road, Stepney; J. A. E. Hickson, Luiden House, Hornsey Lane, Highgate; J. Munro, The Mount, New Barnet; J. W. Knowles, 39, Manor Road, Brockley, S.E. The number of directors is not to be less than three nor more than nine, the first to be elected by the subscribers. Qualification, 250 shares. Remuneration, £1,500 per annum, divided between them. Registered on the 28th ult., by Hays, Schmettan & Co., solicitors, 31, Abchurch Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Head, Wrightson and Company, Limited (engineers, contractors, ordnance manufacturers and suppliers of electricity).—The first annual return of this company, made up to the 4th ult., was filed on the 14th ult. The nominal capital is £210,000 in £5 shares, all of which are taken up, upon 28,001 of which the full amount has been called and paid, and upon the remaining 13,999 the full amount has been considered as paid. Share warrants for 5,000 shares are outstanding amounting to £25,000. Office, Teesdale Iron Works, Stockton-on-Tees.

Manchester Edison-Swan Company, Limited.—The annual return of this company, made up to the 29th ult., was filed on the 4th inst. The nominal capital is £550,000 divided into 50,000 "A" shares of £9 each and 10,000 "B" shares of £10 each. 20,000 "A" and 10,000 "B" shares have been taken up, and upon all of the "A" shares £1 per share has been called and paid, while upon all of the "B" shares the full amount has been called and paid, the calls paid amounting to £120,000. Office, 14, St. Ann's Square, Manchester.

Chili Telephone Company, Limited.—The annual return of this company, made up to the 28th ult., was filed on the 4th inst. The nominal capital is £250,000 in £5 shares, of which 40,000 are taken up, the full amount called, and all calls paid. Office, 42, Old Broad Street, E.C.

Lancashire and Yorkshire Electric Lighting Company, Limited.—The annual return of this company, made up to the 9th ult., was filed on the 5th inst. The nominal capital is £100,000 in £5 shares. 127 shares have been taken up, upon all of which £2 10s. per share has been called and paid with the exception of one sum of £2 10s. Office: 5 and 6, St. James's Square, Manchester.

Akester Electro-Motor and Accumulator Company, Limited.—The annual return of this company, made up to February 28th, 1890, was filed on the 5th inst. The nominal capital is £5,000 in £1 shares, all of which are taken up, and upon 1,500 shares 16s. per share has been called, while the remainder have been considered as fully paid. The calls paid amount to £1,088, and unpaid to £112. Office: 36, Great James Street, Bedford Row, W.C.

J. and E. Hall, Limited (electrical and general engineers).—At an extraordinary general meeting of the above company, held on May 22nd, 1891, at the office, 23, St. Swithin's Lane, E.C., the following special resolution was passed and afterwards confirmed on June 19th, 1891:—"That the annual remuneration of the managing directors be increased from £1,800 to £2,000 per annum."

New Telephone Company, Limited.—Upon the petition of Prof. S. P. Thompson, of the Technical Institute, Finsbury, and E. Garcke, of Victoria Works, Belvedere Road, Lambeth, on June 3rd, 1891, before Mr. Justice North, Chancery Division, all further proceedings in relation to the winding up of the company have been ordered to be stayed (filed on the 25th ult). The office has been removed to 90, Cannon Street, E.C. (filed 7th inst).

Williamson Electrical and Engineering Company, Limited.—The notice of the increase in the capital of this company which was resolved at an extraordinary general meeting on the 3rd ult., and subsequently confirmed on the 21st ult., was filed on the 31st ult., bringing the capital up to £25,000. Office, 14, St. Ann's Square, Manchester.

House-to-House Electric Light Supply Company, Limited.—An alteration in clause 115 of the articles of association of the above company, passed 7th ult. and confirmed 24th ult., both at extraordinary general meetings held at the Central Electric Lighting Station (Kensington), Richmond Road, S.W., was filed on the 8th inst. Office, 117, Bishopsgate Street Within, E.C.

Devon and Cornwall Electric Light and Power Company, Limited.—The final order for winding up the above company upon the application of A. A. James, the official liquidator of the company, was filed on the 5th inst. Office, 110, Cannon Street, E.C.

CITY NOTES.

City and South London Railway Company.

The fourteenth ordinary general meeting of the shareholders of the above-named company was held on Tuesday last at Winchester House, Old Broad Street, under the presidency of Mr. Charles Grey Mott.

Mr. W. F. Knight (the secretary) read the notice convening the meeting, and the report (which has appeared in the Electrical Review), was taken as read.

The Chairman moved: "That the report and statement of accounts for the half-year ended June 30th, 1891, now submitted to the meeting, be approved and adopted." He then said: There is one matter connected with this report which I am sure you will have read with satisfaction, and that is that we have been enabled to carry 2½ million persons during the half-year to which this report refers without any accident whatever on the line. I regret that a few days ago, for the first time in the history of this company, a fatal accident occurred in connection with the line. But as the passenger in that case acted in violation of the bye-laws of the company, and in direct defiance of the officers of the company who were carrying out those bye-laws, no blame can be attached to the company itself in the matter at all. At the same time, you may be sure that we regret such an accident exceedingly, and that we sympathise very much with the relatives of the passenger who was unfortunately killed. The past half-year has, as you can well imagine, been a very anxious one for the board. In the first working of a new system such as this, three points are naturally presented to the directors of a company situated as we are: Firstly, Will the system of electric locomotion which we have adopted work at all? secondly, Will it work satisfactorily? and, thirdly, Will it work in such a way as to give a remunerative return to the shareholders for the money they have invested? On the first two heads we can reply with confidence in the affirmative. We have worked the railway, and we have worked it satisfactorily. As regards the last head, I am sorry to say that at the present moment we cannot answer with the same satisfaction that we can answer the first two. We have yet in the future to show that this system is not only an efficient system, but is one that will be a thorough financial success. As you have seen from the accounts, the past half-year has given us a profit which has enabled us to pay our debenture interest in full, and has left us a very slight margin beyond. As we have no other preference charges at the present moment beyond our debenture interest, and beyond a very small sum that we may be able to pay for the preference shares that may be issued—it is not a large amount, for, as you know, it is very small indeed—any further profits on this line will go into the hands of the ordinary shareholders. I hope that the future profits of the line will go on steadily increasing, and that it will not be very long before I may have the pleasure of standing here and telling you that we have earned a substantial dividend. But that rests with the future, and I do not like to prophesy on that point. You know I have always refused to do so, and wisely, I think. We have rather to deal—I prefer to deal—with accomplished facts rather than with any roseate view which may or may not be carried out. Now you may like to have some short *résumé* of our present position financially. Our receipts for passengers during the past half-year—and they are the only source of receipts we have at the present moment, because we have practically no other traffic over the line—they amount in the whole, as you will see in the revenue account, to £19,403. We have received a small sum from transfer fees, rent of property, and other things which bring the total for the half-year up to £19,637 10s. 3d. We have received that by carrying 2,412,343 passengers. The number of passengers per train mile that we have run is 17. Well, now, if this were an ordinary railway that would be a very large number, because the general average of the large English railways is only about 3½ passengers per train mile. The general average of all the railways, including the suburban railways and others in this country, is about five passengers per train mile, while we have carried 17. But then, of course, ours is a purely metropolitan line, costing very much, and the traffic is expected to be very much heavier than the ordinary railways of the country. Now, you may say, Is your capacity for carrying the traffic at its maximum? No. With our present train service we could carry three times the present number of passengers if we had them to carry, and they were stretched over the whole 24 hours. Therefore we have capabilities of developing even upon our present system of working, and the present number of trains we run. We propose to run, and hope before long that we shall be running more trains, and if the traffic grows as we hope it may grow, steadily, we shall be able to take a very much larger number of passengers. Now our earnings per train mile have been 2s. 9d. Of course the earnings per train mile on a line of this kind ought to be larger than on the ordinary railways. Unfortunately at present it is not, because we are not carrying the relative traffic of those railways that we ought to carry. The average receipts from passengers, pure and simple, apart from parcels and mails, carried by passenger trains on the London and North Western, for instance, the average receipts are there 3s. 3d. per train mile, against our 2s. 9d. Some railways, of course, earn more than 3s. 3d., and all the large railways benefit, of course, from the receipts which they get from other things carried by passenger trains, such as parcels, horses, carriages, and things of that description, and mails, also, for instance. As regards our expenses they have been, as stated in the report, undoubtedly heavier for the past half-year than the present rate of expenses at which we are now working. In the earlier stages it was necessary that we should have a very large staff to deal with the traffic, which was unknown and which was new, and we had also to have expensive men attached to the staff in a new system of this kind. Considerable reductions have been made in the expenditure, and we are working now at a less rate than we did in the earlier days of the concern—considerably less. That, of course, is one of the

pleasing features of the future. All our stock is new, and we have yet to learn the cost of maintenance of some of that stock. I do not think it is likely to turn out that we shall have a very heavy item of maintenance, at least not from our experience so far. Our permanent way expenses are not likely to be so large as those of the ordinary railways. Our locomotive source is the one point which, at the present moment, compares unfavourably with the ordinary work of the steam railways, but I would venture to caution you against taking the amount which at present appears in our accounts under locomotive and generating powers as a permanent and absolutely certain fact. It has been difficult, especially in the early part of the half year, to distinguish exactly what was the permanent charge in that respect, because our motive—that is to say, the power derived from the steam, is used for various purposes beside that of working the locomotive power itself, and the absolute division between these two in the present half-year is not an absolutely ascertained fact. It is assumed, rather than ascertained, but in the future we hope to have it as an ascertained rather than an assumed figure, and we shall be able to deal better with this account in another half year, and more accurately than at present. The expense of running per train mile is charged in these accounts at about 11d. That compares with the ordinary steam railway charges, varying from about 9½d. up to about 1s., so that we may be said to be not far, in this past half-year, from being on a par with the ordinary charges per train mile of the steam railways. But of course our trains are very much lighter, and will not carry so many passengers as the steam railway trains will take; still, as we carry as many passengers at the present moment as we have to carry, we do not send any of them away, and we are not losing anything practically by having smaller trains. I am not sure that in the future the system we shall adopt will not be one of lighter trains run more frequently, and that it will not prove in the end more economical and more conducive to the public comfort than running larger trains, which on many ordinary railways run comparatively empty. Now we had to contend in this half-year with a great many difficulties, and we are trying steadily to overcome them. They are not serious difficulties, any of them, and these small improvements which we are making, and hope to make will, I think, render the railway much more popular in the future, when they are carried out than it has been in the past. At the same time, any one who has used the railway will, I think, feel that as far as the comfort, safety, and all the general accessories of convenient railway travelling are concerned, our railway is really not inferior to any of the ordinary steam railways, and we hope in the future to make it very much superior, and I believe, when all our improvements are carried into effect, it will be at once confessed that we have brought into use a system of locomotion which will be a decided improvement upon anything which has hitherto been in existence. The old stage coaches in the past had their day, and were efficient enough in their day, which lasted for some 60 years. It remains to be seen now whether, after all, the time has not arrived when some new departure ought to be made in our mode of locomotion. Whether electricity is the improvement, and is to be the new departure, has, I think, yet to be proved; but we have the satisfaction of knowing that, at all events, we have tried to do something towards the development of an improvement in the future, and I hope that it will not only prove a success as regards public convenience, but as, I believe, the time will come when I may be able to congratulate you that it is also a success financially. The improvements we are making are in various directions, and we have had new carriages—two new trains of carriages—built. They are now on the ground, and being put together ready for working, and I think they will be found to be a decided improvement on the old ones. We have two new locomotives built which we also believe will improve the speed and the regularity of the trains. The lighting of the trains is having our special attention, and half of them are now lighted on an improved principle, which I think will be still further developed. It is the electric light, and hitherto the electric light has been somewhat uncertain, but I think we are now making it into a certain and fixed light, which will be thoroughly satisfactory for the purpose. We have just placed two new boilers in position, so as to give us additional power. We have a new engine and a new dynamo nearly ready for delivery, and before long we shall be in a position to cope with the traffic which comes to us, as, unfortunately, all suburban traffic does come in an irregular manner—in the morning and evening you have a heavy crush of people, and in the middle of the day of course we shall be glad of more passengers than we have. We hope to get our increased traffic first from disabusing the public mind of the prejudice which exists at present very largely against travelling by an underground railway of this description. When the Metropolitan Railway first opened those who recollect it will recollect how very strong the prejudice was against any one travelling underground. People have now got over that prejudice; but, of course, with a railway two stories underground and worked by a power so little known as electricity it is not surprising that there is, on the part of some of the public, a great deal of prejudice to be overcome I believe when we have everything in working order we shall overcome that prejudice, as the Metropolitan Railway did, and that our traffic will steadily increase. We also hope to get, and are getting, an increased traffic from the growth of the population on the route. The houses formerly unoccupied are now being occupied, and new houses are now being built in consequence of this line going in that direction, and naturally there will be a growth of population. And, in addition, we always find that increased facilities for traffic produce increased traffic. Therefore, we have every hope that this line, like other railways, will steadily grow in traffic, and as I think our expenses will not grow in the same proportion as they do upon ordinary steam railways, we have, I think, some hope for the future, although, unfortunately, it is a hope deferred for the present moment, and I am not able, as I should have liked to have been at our first meeting, to declare a dividend. The question, as I have stated at previous meetings—one of the most important questions that we have to consider—is how to fill up the trains during the central part of the day. We have made an effort to do that in certain cases in the half-year—in the last two or three months—by reducing the fares from 2d. to 1d. from certain stations at certain stated times of the day. The result has been, so far, satisfactory. It has resulted in our carrying from those stations at that time already three times the traffic we carried before, and therefore our receipts are increased at these stations some 50 per cent. Of course, whether the development of that—whether the decreasing of the fares at other stations would produce a like result is what we have to consider very carefully. So long as our trains are full at 2d. it is not to the interest of the company to reduce the fares. We regret to have to alter the idea of a perfectly uniform rate all over the line, but however much you may be attached to a particular system we felt it was our duty to adjust our ideas to the circumstances that arise from time to time, and to endeavour in every way to increase the popularity of the line and its resultant receipts. You will remember that we agreed to go to Parliament for an extension of this line through the City up to the Angel at Islington. That would have been a very good line in itself, and I think it would have paid very well, and would also have brought to the existing line a very considerable increase of traffic exactly at the time when we wanted it. Unfortunately circumstances occurred in the first Committee of the House of Commons which led the committee to throw out the Bill. There was a very slight opposition to the Bill itself—the only remaining opposition at last was the Corporation of London, and even they, I believe, did not wish or desire that the Bill should have been thrown out. But circumstances quite apart from that arose in the committee, and with which we really had nothing to do, which perhaps induced that committee to throw out the Bill. The question in our present financial position is that it is very doubtful whether we shall come to you again with the recommendation to go for that extension again, because, until we have brought up the price of our present shares in the market it might be doubtful whether we could issue the capital except at such a large reduction as would make it undesirable to do so. However, between this and the next Parliamentary time I believe we shall have to consider the question, and if we can see any way of carrying that out without burdening the existing company, we should much prefer to do that. The question of the Clapham extension remains as a separate item, for the moment, until we see in the future what shall be done with it. We have not dealt with it, but it is in the balance sheet as a separate item, so, as I have already told you at the previous special meeting, we have in fact, the new plant. We are putting it down, and it is intended as part of the plant which will ultimately work that extension, but the same reason that induces us not to suggest to go on immediately with the Islington extension applies to our not carrying out the Clapham extension for the moment. But we do propose to do certain things as part of that work, which will be available for the use of the present line, and form part of the Clapham extension in the future. There is nothing further to refer to except one or two points in the report. You will see by the report that action was taken against us by the County Council. That action was a very arbitrary action on the part of the council, which had no good case as regards ourselves, but really had for its object the testing of the particular rights which they could "try on" on a small company like this better than with a larger company. We felt there was no alternative but to oppose that action, which we did successfully, and also, when it came before the Court of Appeal, it was there confirmed in our favour.

Mr. SAMPSON HANBURY seconded the motion for the adoption of the report and accounts.

Mr. PETO hoped the directors would most seriously consider the matter before resolving to again proceed with the Islington extension scheme. He did not think they would lose anything by waiting to see what there was in store for them for the future as the result of the working of the present line. With reference to the appointment of a director in the place of Mr. Robinson, whilst he (Mr. Peto) did not wish that the directors should not be adequately paid, still he thought they might well consider whether the number could not be reduced to three, bearing in mind that the expenses were necessarily very heavy for so small a line. The shareholders in a new undertaking of that character must learn to wait, but there was no cause whatever for despondency. He hoped there would soon be a brighter future.

The CHAIRMAN, in reply, said: I can assure Mr. Peto that we have as much desire as he has not to commit the company to any expenditure we can possibly avoid. And as regards the Islington extension, I do not think there is any likelihood of our going on at the present moment with that. As regards the question of four directors intead of five—

Mr. PETO: Three, I suggested.

The CHAIRMAN: Well, unfortunately we are bound by Act of Parliament, and we cannot very well do with less than five. We are bound to have three at present to form a quorum. You could not act without, and in the case of illness, or the absence of a director, it is almost impossible to get that quorum unless you have five directors. I know that on some boards there are only four, but it has very often been the cause of considerable inconvenience, because it is quite impossible to foresee everything at a moment, and five directors for any concern which requires to be continually looked after, is found to be as small a number as is practically good. I quite agree with Mr. Peto, and am not in favour of large boards of directors; but at the same time you must have a sufficient number to make your working certain. Of course the income of the company looks at the present moment small, but the work, as anyone connected with it knows, is not by any means small. It is a railway which requires a very great deal of constant attention and management, and although we have tried to reduce the expenditure, we cannot do without an efficient staff at our headquarters. You must remember

that the number of passengers carried is very large, and the number of trains run is exceptionally large. The length of time the trains run is considerable, and the number of hours is so great that we are obliged to duplicate the staff very often. We cannot keep men at work for 18 hours at a time every day. This therefore necessitates a larger staff than is absolutely proportionate to the traffic at the present moment. But the relative expenses of that will diminish as the traffic increases, because it will not be necessary to increase the staff. That is one of the advantages we shall get from this mode of working. As regards the appointment of a director, I believe that you will think we have made an excellent choice in Mr. Heward. He is the representative of a very large shareholder's interest in this company, and he has given us the benefit for a long time of his advice in many matters at the board without being a director of the company, and by that means he has acquired a considerable knowledge of the company's affairs, and we therefore thought that we could not do better, when we had a vacancy, than that he should take a seat on the board.

The report was then unanimously adopted.

A vote of thanks to the chairman having been passed and briefly acknowledged, the proceedings terminated.

Montevidean and Brazilian Telegraph Company.

A GENERAL meeting of the shareholders of the Montevidean and Brazilian Telegraph Company was held at Langthorn House, Copthall Avenue, E.C., on Tuesday last, Col. MacAulay presiding, for the purpose of receiving the liquidator's report and winding up account.

The report of Mr. Geo. Fraser, liquidator, stated that the number of shares in the Western and Brazilian Telegraph Company, Limited, issued as the consideration for the purchase of the undertaking of the Montevidean Company was 5,300, as stated in the directors' circular of November 11th, 1890. These shares were distributed as follows, in accordance with the special resolutions confirmed on December 10th, 1890:—To shareholders in the Montevidean Company, 4,343; to debenture holders in the Montevidean Company, 650; to the liquidator, in satisfaction of his remuneration, 10; to the directors and secretary, as compensation for the loss of their offices, 145; total 5,148. Unappropriated balance, to be sold and proceeds applied towards the expenses of the liquidation, 152; making in all 5,300. The Western and Brazilian Company applied to the Stock Exchange on June 11th for a quotation for these shares, which would, no doubt, be granted as a matter of course, although the reply had not as yet been received. As shown in the cash account, the unappropriated shares had been sold at £10 17s. 6d. per share, the proceeds amounting to £1,653. The expenses of the liquidation, amounting to £164 16s. 5d., had to be paid out of the proceeds of the abovementioned shares, together with an amount of £380 for the redemption of debentures not previously charged to the company's revenue account. As shown in the cash account the balance would allow of the payment of a first and final dividend of 2s. 5d. per share to the holders of all shares, whether preferred or deferred, in the Montevidean Company, amounting in all to £1,050 12s. 11d., and leave the sum of £26 9s. 5d. still unappropriated. It would be for the shareholders who attended the meeting to decide as to the mode in which this balance should be applied. As further expenses had to be incurred, the liquidator suggested that the whole of the unappropriated balance should be voted to him.

On the motion of the CHAIRMAN, the report and accounts were adopted; and the thanks of the shareholders were given to the liquidator for the rapid and efficient manner in which he had conducted the liquidation.

United River Plate Telephone Company, Limited.

THE fifth annual ordinary general meeting of this company was held on Friday, August 7th, at Winchester House, Old Broad Street, E.C., for the purpose of presenting the report, an abstract of which was published in the ELECTRICAL REVIEW of last week.

The SECRETARY having read the notice convening the meeting, the report and accounts which had been in circulation for some days were taken as read, and,

The CHAIRMAN (Mr. J. Irving Courtenay), addressed the meeting as follows:—Gentlemen,—I rise to move the adoption of the directors' report and statement of accounts. When I last had the pleasure of addressing you, now 12 months ago, I certainly did look for an improvement in River Plate affairs, but very shortly after the last meeting a revolution broke out in the Argentine Republic, and from that day to this it cannot be said that there has been any improvement financially; on the contrary, the gold premium has fluctuated violently, and the recent unfortunate failure of the English Bank of the River Plate has caused, if possible, an increased want of confidence on this side. The failure of that bank had no effect upon this company directly as it was not one of our bankers. By the direction of the board an account which we had with its Rosario branch was transferred nearly a year ago to the London and River Plate Bank. I am aware that it is the opinion of many that matters have reached their worst, and there are undoubtedly some hopeful features in the situation, but the position changes so rapidly that I think it the wisest course not to attempt to give any strong opinion at present as to the probable course of events in the near future in the Argentine Republic. Regarding the results of the past year's working in our company, they have been entirely governed by one factor, namely, the gold premium to which I will call your attention later on. The gross income for the past financial year was £106,259 19s. 8d., as compared with £108,612 2s. 7d. in the previous year. The difference arises solely from the diminution of our sales business which, in consideration of the long credits customary in the River Plate, we have not thought it prudent to push. I desire to call your particular attention to the strength of the company's business notwithstanding the continued crisis, as shown by the figures I have just given. There has actually been more money received from subscribers and messages this year than was received last year, though there has been a considerable falling off in the total number of subscribers. We have had no less than 1,099 new subscribers come on our books during the past year, and I believe that our experience will be the same as has been found in other enterprises, that the subscribers who come on the list during a period of financial tightness are more permanent subscribers and are better payers than those who come on during a period of inflated commercial prosperity. You must understand that there is no diminution in the demand expressed for telephonic communication, but our representatives in the Plate are wisely prompt in removing telephones from bad payers. Our working expenses in the Plate were £56,941 1s. 9d. against £63,497 15s. 5d. for the previous year. This reduction of £6,566 13s. 8d., being over 10 per cent., has been the result of economies made where practicable, notwithstanding the increased cost to a considerable extent of materials, general expenses and taxes. The directors have endeavoured to effect all economies possible in the management and expenses of the company, and in this they have been effectively aided by our managers in the River Plate. Further economies, to some extent, are anticipated, and are in progress of being carried out, but unless a reduction in the gold premium occurs a greater degree of expenditure must be expected; this would necessitate such a rise in our rates as would at least meet the increased expenditure. The capital outlay for the year has been £3,096 10s. 10d. against £12,772 8s. for the previous year, and though this figure is low, still a considerable amount of important work has been done which has been charged to revenue, such as a complete installation of lightning arrestors which will prevent serious damage to our whole plant including the multiple switchboard at the central station not only from lightning but from contact with electric light wires. We have also pulled down old lines of the two former companies and have built several miles of new trunk lines, thereby reducing taxes on posts and expenses of working and maintenance. Our Buenos Ayres manager reports that our plant to-day is in excellent condition in every respect and that its working is perfect; and from our other important centre, Rosario, the manager writes:—"It is a great pleasure to me to be able to inform the board that the service I am sure cannot be beaten in any part of the world, complaints there are none." We had the advantage of a personal inspection by one of our directors, Mr. Cooper, during last spring, who, on returning to this country, gave a most satisfactory report both as to the efficiency of the service and the general management of the business. The directors, mindful of the necessity for diminishing expenditure in all directions, have, as stated in the report, reduced the London fixed expenses since the end of the financial year by one third, so that these expenses now stand at about one-half of what they were for the previous year, *i.e.*, the year ending March 31st, 1890. I have now, I think, touched upon most of the points in the report and the figures in the balance sheet, and I can but express my great regret that we are unable for the first time in the history of the company to declare a dividend; this is entirely owing to the loss on exchange amounting to £36,049 0s. 8d., or nearly 12½ per cent. on the company's paid up share capital—a loss, of course, wholly beyond our control. In spite of the extremely adverse circumstances we have had to contend with in the River Plate, and of which you are fully cognisant, the business of the company has held its own remarkably well and shows an undoubted vitality; so that it may reasonably be expected that with only a slight revival of commercial affairs in Buenos Ayres, and a fall in the gold premium, the company would soon again be in a dividend paying condition. I may properly mention here that the latest telegraphic advices from Buenos Ayres, dated the 4th inst., state that our receipts for July are better than for the same month of last year. We cannot but regard that as a most encouraging feature. Several changes have taken place during the past year in the administration of the company. We have met a severe loss in the death of our colleague Mr. John Coghlan, a gentleman widely and most favourably known in connection with River Plate affairs for very many years. Lord Thurlow, who was with us from the beginning as our chairman, felt obliged, owing to the pressure of his other engagements to resign his office as a director, which the board very much regret. Our secretary, Mr. Unwin, who has also been with us from the outset, resigned his post at the end of the year to enter into partnership with an old established South American house. The board desiring to retain the valued services of Mr. Unwin and his long business experience in South America elected him to the vacancy caused by the death of Mr. Coghlan. It also appointed to the vacant secretaryship, Mr. Robert Herring, who has always been the company's accountant, and who now unites the duties of both positions. Feeling the necessity of a more general supervision of the company's affairs under this re-arrangement of the home management than could well be given by an ordinary director, the board have thought it wise to ask Mr. F. W. Jones, one of its members, to take the position of managing director, which I am pleased to state was accepted. Mr. Jones, who is one of the largest share and debenture holders was, as you will remember, chairman and managing director of one of the enterprises in the River Plate, upon which this company was founded. I shall conclude my remarks by moving the resolution, "That the report and accounts submitted to the meeting be and are hereby received and adopted by the company."

This was seconded by Mr. GEORGE COOPER.

A SHAREHOLDER (Mr. Ellis) required some explanation regarding the very heavy loss on the exchange caused through fluctuation of gold premium. He also asked whether it was really necessary to turn all their paper money into gold at once, or whether a certain proportion could not be kept in the River Plate. These questions were satisfactorily answered by the chairman who stated that the company doing business in this country have their auditors here, and

the whole of the accounts being checked and audited by them, the company were bound to convert all their money into sterling. The directors had to bring the accounts before their shareholders in £ s. d. and they were therefore bound to convert it into sterling. After further discussion on the matter the report was carried unanimously.

The next business was the re-election of directors. Mr. JONES proposed and Dr. RAE seconded that Mr. Courtenay be re-elected as chairman. This was carried unanimously.

It was then proposed by Mr. FREDERICK GREEN, seconded by Mr. BILLITER and carried unanimously, that Mr. John Owen Unwin be elected a director of the company. The auditors, Messrs. Cooper Brothers and Company, were next re-elected.

A vote of thanks to the Chairman was then proposed by Dr. RAE and carried, and the CHAIRMAN in replying, said: I have to thank you for your very kind vote of confidence, which I take to be a vote of confidence in my colleagues as well as myself. I hope the next time we meet we shall have some of the clouds dispelled.

This terminated the proceedings.

The Cuba Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ending 30th June, 1891, which was presented at the 40th ordinary general meeting of shareholders held on Wednesday last, states that the gross receipts (including the balance brought from last account) amount to £23,586 2s. 1d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the expenses in connection with cable repairs) to £10,997 6s. 3d., leaving a sum of £12,588 15s. 10d. to the credit of revenue account.

Of this the sum of £2,656 5s. 10d. has been added to the reserve fund, which now stands at £78,000.

The dividend on the preference shares will absorb £3,000, and leave £6,932 10s., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £532 10s., being carried forward to the current half-year's account.

The company's engineer, Mr. Keith, who superintended the submersion of the new cable between Batabano and Cienfuegos, reports that it was well laid and has been tested with satisfactory results.

The Cienfuegos-Santiago 1875 cable, which became interrupted on January 13th, as mentioned in last report, was restored to working order on February 3rd, while the Batabano-Cienfuegos 1870 cable, which was broken on February 22nd, was repaired on March 28th. These repairs were economically carried out by the company's engineer, and the whole cost is charged against the revenue of the half-year.

The Cienfuegos-Santiago 1881 cable, referred to in the last report, has been repaired at the cost of the contractors.

The whole of the company's submarine system is now in duplicate and in good working order.

The suit against the Spanish Government for the protection of the company's concession is progressing, and the full statement of the company's case has been lodged with the Contencioso Court.

The directors have, with much regret, to announce the death, on February 22nd, of Mr. Horatio J. Perry, who had been a director from the commencement of the company, and had well served its interests at Madrid. Mr. Charles Woodbyne Parish has been appointed in his place.

The director who retires from the board at this time is Mr. Thomas Greenwood, who, being eligible, offers himself for re-election. Mr. John Gane, the auditor, also retires, and offers himself for re-election.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN (Mr. Thomas Greenwood) said that the board had very little intelligence to give them other than that given in the report. As so many of the shareholders could not possibly attend the meeting, the board always gave all the information likely to be required in the report. Apprehending, therefore, that they were acquainted with that document, he moved that the report and accounts be received and adopted. He drew the shareholders' attention to one or two points. The receipts for the last half-year, as compared with the corresponding period of the previous year, were not quite so large, this was not owing to want of trade, but to the breakdown of one of their cables for a few days. They had their cables in duplicate from end to end, and it was highly improbable that such circumstances would occur again; they hoped, therefore, that the public service might be continued without any further interruption and no loss could accrue to the company. Some repairs had been completed during the last half-year, and the charge was less than in the corresponding period, therefore, the result was that they had a larger sum to carry to reserve fund. The reserve, as they would see, was £78,000. They had spent about £22,500 in the new cable, so that had it not been for that outlay the reserve fund would have amounted to rather over £100,000. The chairman thought it a very satisfactory state of affairs. The suit with the Spanish Government was making slow progress; law suits as they knew did not go very fast in England, and in Spain they were more lethargic than here. The Government had lodged with the court the papers which were in their hands, which it was necessary to do, and the company had made their plaint within 10 days, the time laid down, and the case was at present before the court. The chairman could scarcely give an idea when the decision would be given, but they might say that as far as they (the Company) were concerned there may be a perpetual delay. They wanted the decision, that the Government had not the right to grant this concession which they claim to have a right to do, and until that is decided they were going on with their business, and so far the delay was beneficial to them. He stated that there was nothing more in the report or in the circumstances of the company as a whole that he needed to mention, but if there was anything further than he had already intimated, upon which they required information, he would be very pleased to give it. He then moved "that the report and accounts to June 30th last be received and adopted."

This was seconded by Mr. LOW.

Mr. COCKERELL then asked for some explanation as to the depreciation on stores and cables in stock. He found on looking back on the previous three half-years that they had been charged £313, £223, and £219, but this year it had sprung up to £734. He did not quite catch what the chairman said as to the £100,000; he supposed they were the accumulated payments for the new cable.

The CHAIRMAN said that was not so; they had now a reserve of £78,000, after having spent more than £22,000.

Mr. COCKERELL then stated that it seemed a rather severe tax upon their revenue that something like £8,000 was written off in one half-year for charges. They had half of the annual payments on the Santiago cable. They had payments to pay £3,698, and then they carry to reserve fund £2,656, making altogether £8,869 for the half-year. He had always thought it a wise thing to maintain the company in a sound financial position, but at the same time he thought it rather severe docking all their profits. No doubt it makes the future more secure, and he did not know that he should be prepared to do more than simply to draw attention to it. It seemed rather a heavy sum to deduct from the gross amount of their profit.

Mr. GRIFFITHS (another shareholder) then said that he rather agreed with the last speaker in that the reserve fund was at a very high figure. He was certainly in favour of safety and it was necessary to ensure this, but they were fortunately in connection with a company which takes a rent for their lines and therefore they did not need so strongly, as other companies did, a reserve fund; other companies bought their own cables and were enabled to ensure against any risks to them and therefore it was necessary to have a large figure in reserve. They had the additional safety of renting their cables and the insurance of it being included in the rent, but of course that was a question of policy which required consideration. He would merely suggest that they would like to see the reserve fund kept down and the dividends if possible increased. It might be a selfish policy, but he thought, under the circumstances, it was a safe one. He asked if the new Halifax line was likely to affect them.

Replying to the remarks of these two gentlemen, the CHAIRMAN stated that the stock of their materials was always valued by their engineer, and they get his certificate at the end of every year. This time they had had the whole stock overhauled, and it was found that there was a little increase in depreciations of stock. The stock was there whatever they valued it at, and it was really a little more than the figures given. The figures which had been quoted were no doubt quite accurate, that they had charged the revenue with large sums during the last half-year. This was mainly because the repairs had come into this half-year. All repairs must be borne by the revenue. Everything had been brought into account of the one line that they had taken from the manufactories. He did not see why they should have any reason to alter revenue; 10 years of the rent had been paid, and after two years more the line would be their own. He did not think it wise to increase the dividend under the present circumstances. They had, as the shareholders knew by this suit before them, the possibility of an altered position. He hoped the dividend would never go below 8 per cent. He thought it a highly satisfactory dividend at that, even though they may put something more to the reserve fund. He thought the shareholders would generally feel it to be wise. Regarding Halifax, the line had been made from Halifax to Bermuda, but they had heard nothing more of it. They anticipate its being extended beyond Bermuda. If there was any opposition at all they expected it would be by the French Company, and the chairman thought they were perfectly safe for the present.

The resolution was then carried unanimously.

The CHAIRMAN then proposed and Mr. CHARLES W. PARISH seconded, "that the following dividends for the half-year be now declared, upon the preference shares of 10 per cent. per annum, and the ordinary shares at the rate of 8 per cent., free of income tax."

This was also carried unanimously.

Mr. Low next proposed, and it was seconded and carried, "That the chairman, Mr. Thomas Greenwood, be re-elected."

It was then proposed that Mr. John Gane be re-elected auditor of the company at a salary of 20 guineas. This was also seconded and carried.

Mr. HOOPER moved a special vote of thanks to Mr. Keith, the company's engineer. This was seconded by the Chairman, and carried unanimously.

A vote of thanks to the chairman and board for the general management of the affairs of the company, closed the proceedings.

The Western Counties and South Wales Telephone Company, Limited.—The half-yearly warrants for dividend to June 30th last, on the preference shares of this company at the rate of 6 per cent. per annum, were posted on Saturday the 8th inst.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the weeks ending July 31st and August 7th, were £4,251 and £4,243, respectively.

The City and South London Railway Company. Traffic receipts for the week ended August 8th, were £821 gross.

The Western and Brazilian Telegraph Company, Limited. The receipts for the weeks ending July 31st and August 17th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company were £2,696 and £2,680 respectively.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 6.)	Closing Quotation. (August 13).	Business done during week ending August 13, 1891. Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101	99 —102	99	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	43 — 44 xd	43 — 44	44	43
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	82 — 83 xd	82½— 83½	83⅜	82⅜
2,849,510*l*	Do. do. Deferred	Stock	9½— 10	9½— 10	10	...
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12¼	11⅜— 12¼	12⅛	12
53,200*l*	Do. do. 5 p. c. Bonds	100	99 —102 xd	99 —102	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2⅜— 2⅝	2 7/16	...
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅞— 2	1⅞— 2	1 15/16	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	105 —109	105 —109	108	107
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5 xd	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10 — 11 xd	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	16½— 17½xd	17½	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3⅜— 4¼	3⅜— 4¼	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅜— 10⅝xd	10¼— 10⅝	10 13/16	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14¼— 14½	14⅝	14¼
70,000	Do. 6 p. c. Preference	10	15 — 15¼xd	15 — 15½	15⅝	15⅛
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109 xd	106 —109	106½	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	107 —110	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15	14⅜— 14⅞	14⅝	14⅜
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	103 —106	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	104 —107 xd	104 —107	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101 xd	98 —101	100½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3½— 4½	3½— 4½	4⅜	3⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3 — 3½	2⅝— 2⅞	3⅛	2 13/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3⅝— 3⅞	3¼— 3⅜	3 3/16	3 7/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¼— 1⅜	1¼— 1⅜	1 9/16	1½
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9¾xd	9⅝— 9⅞	9⅞	9⅝
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15¼xd	14⅞— 15½	15⅛	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	18½—19	18½— 19	18⅝	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	106 —109	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	19 — 20	19 — 20	19½	19¼
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	40¼	40
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	107 —110	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅝— 10¼	9½— 10	9⅞	9 13/16
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝— 4⅞	4½— 4¾	4 13/16	4⅝
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½—13½	12½— 13½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13	12½— 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —107	105 —107	106⅜	105½
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½— 4½	3½— 4½	...	...
225,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	5/16— 7/16	5/16— 7/16	...	...
10,000*l*	Reuter's Limited	8	8 — 8½	8 — 8½	8 3/16	8
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6½— 7	6⅜— 7⅛	6⅝	6 11/16
7,900	Do. do. 7 per cent. pref.	2	4¼— 4⅜	4¼— 4⅜	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	117 —121	119	117⅜
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅜	4½
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	43 — 45	45	44
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
281,400*l*	Do. do. do. 5 p. c. Debentures	100	96 — 99	96 — 99	97½	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	2½— 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 102	97 —102	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10⅝— 11¼	10⅝— 11¼	11 1/16	11
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6⅝	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4¼— 4⅜	4¼— 4⅜	4½	4⅜
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	101 —104 xd	102 —105	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	100 —103 xd	101 —104	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅞— 2⅛	1⅞— 2⅛	2	1 15/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10¼	10 1/16
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	101 —105	101 —105	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	4⅜—5¼	5 — 5½	5 5/16	5 3/16

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Ordinary of £10 each, £2 paid, 2.—Elmore's Austrian Copper Depositing, 15s., 25s., £2 share issued at 10s. prem., fully paid, 1—1¼.—Elmore's Priorities, 3⅜—4⅛.—House to House Company (£5 paid) 4⅞—5¼.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅝—1⅞.—Manchester, Edison and Swan Company, £9 (£1 paid) 2 — ⅜.—National Telephone Debentures, 2½ — 3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2⅛—2⅜.—£5 Preference, fully paid 3¾—4⅛.—Debentures 90—95.—Wards Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT.—2½ per cent. (2nd July, 1891).

THE ELECTRIC TRANSMISSION OF POWER.*

By GISBERT KAPP.

Lecture II.—Delivered February 23rd, 1891.

(*Concluded from page* 176.)

What we generally desire to get in practice is a constant speed of the motor, whatever may be the mechanical power taken out of it at any moment. This condition is the same as that required from a good steam engine or other well governed prime mover. The construction of the motor to comply with this requirement depends, of course, on the condition of supply. We can imagine a large variety of cases, but from a practial point of view I need only consider two, namely, supply at constant pressure such as we get, or ought to get, from mains connected with a central electric light station, and supply of current at constant or variable pressure from a generator erected specially for the purpose, the regulation of current and pressure being automatic. The latter case is that more particularly met with in long distance transmission of large powers, the former is a case referring rather to the distribution of small parcels of power over short distances from a central station. I will take this first.

We have, then, these supply conditions—pressure at the terminals of the motor constant, current variable, according to the call for power. Let (in the diagram fig. 4) the curve F represent the

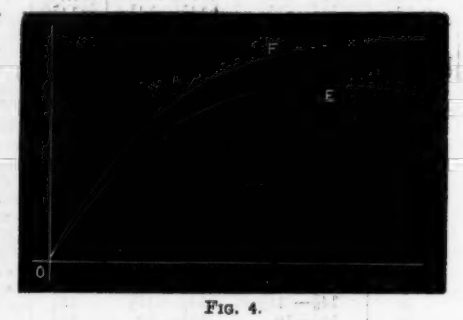


FIG. 4.

characteristic of magnetisation of an electro-motor, that is, a curve obtained by plotting ampère turns of exciting power on the horizontal and total field strength (denoted in the formulæ by F or X) on the vertical. If the motor is series wound you see that the larger the current the stronger will be its field, and by referring to the E.M.F. formula you will find that if the speed is to remain constant the counter E.M.F. must increase in the same ratio as the field strength increases. But the counter E.M.F. must under all circumstances be smaller than the supply E.M.F. by just the amount required to overcome the resistance of the circuit through the motor, and this difference is of course proportional to the current. To satisfy the supply condition the counter E.M.F. of the motor ought to slightly decrease as the load and with it the current increases, then the speed will keep constant. But this is exactly the opposite of what the motor requires. Say the machine is running at a certain speed, and giving out a certain amount of mechanical power. Now increase the load. The immediate consequence will be that the speed is slightly decreased, the counter E.M.F. is slightly decreased, and the current is increased. This will immediately strengthen the field and thus raise the counter E.M.F. again; this will check the current, produce a further drop in speed, and so the reaction will go on until a new stable condition of working is reached at a larger current and lower speed. If we take the load off the same reaction takes place, only in the opposite sense, and the speed may become dangerously high. What I have here described happens of course only if the machine is worked on the rising part of the E.M.F. characteristic E, the part which we would naturally select for economical working. If we over-excite the field magnets, that is if we employ a great deal more field wire than necessary, then we can work the machine on the drooping part of the characteristic shown by a dotted line in the diagram and obtain approximately constant speed between certain limits, but the machine will still be liable to race as soon as we throw the load off completely. We thus find that a series-wound motor is certainly not suitable for our purpose.

Let us now inquire whether we shall be any better off with a shunt-wound motor. The field excitation in such a machine does not depend on the current flowing through the armature as in a series machine, but it is simply the result of the terminal pressure, in other words, whatever current may be required by the armature for giving power, can be and is in fact supplied by the source of current, without in any way affecting the field excitation. If the terminal pressure varies the excitation and the field strength must also vary, but a variation in the working current will not directly influence the field strength. It will, however, indirectly influence it by reason of a subsidiary effect technically termed "armature reaction," and this I shall touch upon shortly. For the present we neglect it, and assume that the curve F correctly represents the field strength as a function of the terminal pressure. In machines having wrought iron magnets the first part of this curve is almost a straight line, and in this region the field strength is consequently very nearly in direct proportion to the terminal E.M.F. To work the motor at this part of its curve all we have to do is to supply it with current at a pressure sensibly lower than that for which it is designed. In good machines the resistance of the armature is very low, so that only a few per cent. of the voltage supplied is lost in resistance, even when the maximum current flows through the armature. If, therefore, we work the motor considerably under its power, the armature loss will be almost negligible, that is to say, the counter E.M.F. will be very nearly equal to the supply E.M.F. Now if you look at the formula for E.M.F., you find that on the left you have a value very nearly equal to the supply E.M.F., and on the right you have a constant multiplied with the product—field strength and speed. But the field strength under our special conditions of working is proportional to the supply E.M.F., and as you thus have the supply E.M.F. on both sides of the equation, it cancels out, and you find that the speed, multiplied by a constant, is equal to unity. This of course holds good for any supply E.M.F. within the straight part of the curve; and we find, therefore, that the speed has a definite value which is independent of the supply E.M.F. We have here arrived at a very remarkable result. It is this, that if you work a shunt motor underloaded and at a lower pressure than it is designed for, you may vary this pressure within certain limits without either altering the speed or the power given out.

As, however, the motor must be large in proportion to its work, the practical use of this remarkable property of shunt motors is limited. What users of these machines want to do is not to get little power out of them, but to get as much power as possible, and, in many cases, more than was intended by the designer. Let us, then, see how we stand in the matter of speed and power regulation when we work the machine throughout the whole range of output for which it is designed. First as to speed. Let us assume that the machine is working at a certain speed giving off a definite amount of power, and suppose we wish to increase the speed. How shall we do it? The E.M.F. formula tells us. You see that field strength and speed occur on the same side of the equation. This means that the one can only be increased at the expense of the other. If we want the machine to run faster we must weaken its field, if we want it to run slower we must strengthen it. The variation of field strength is most conveniently brought about by a variable resistance in the magnet circuit. I have such a resistance in the shunt circuit of the machine before you, and can show you, by an experiment, this method of regulating the speed.

In this experiment we have altered both the speed and power, because, by running faster, we have obtained more current from the second machine and a brighter light in the lamp. Let us now see whether it is possible to keep the speed constant, and yet vary the power. Bearing in mind that the dynamo is a reversible machine, and drawing a parallel between a shunt dynamo and a shunt motor, we conclude that there should be no difficulty in doing this. The fact that a shunt motor is an almost self-regulating machine has been first pointed out by Mr. Mordey in an article which appeared in January, 1886, in the *Philosophical Magazine*. Mr. Mordey's reasoning was somewhat as follows:—We know that a shunt dynamo will, if driven at a constant speed, give an almost constant terminal pressure, no matter how the current may vary. Consequently, a shunt motor, if supplied with current at constant pressure, will run at an almost constant speed, no matter how the load may vary. On testing his theoretical deduction by actual experiment, Mr. Mordey was able to completely verify it. In one set of experiments the supply current was kept at 140 volts, and the load on the motor was varied from 1·8 to 16·3 horse-power, yet the speed only varied by 3 per cent.; and a similar result was obtained with the same machine at a supply pressure of 100 volts. Mr. Mordey stated in his paper that the magnetic distortion of the field was nil, or, as we might also term it, that the armature reaction was negligible. It is, however, easy to see that, even if the armature reaction is sensible, we can yet obtain very fair regulation, provided we take care to have in the armature circuit such a resistance that the voltage loss due to the resistance is about equal to that due to armature reaction.

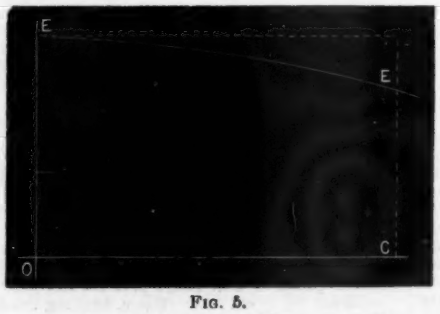


FIG. 5.

To explain this, I must first say a few words about armature reaction, a phenomenon which may perhaps not be familiar to all of you. The current, flowing through the armature, transforms it into an electro-magnet, which, to a certain extent opposes the flow of magnetic lines emanating from the field magnets. This is the case, both in dynamos and motors, though not quite to the same extent. The larger the current, the larger is this opposition which the armature offers to the field magnets; and it is the field strength which remains, after making allowance for this opposing magnetic force, which is productive of electromotive force. To calculate correctly the counter E.M.F. of a shunt-motor, we must, therefore, not assume the field strength in

* Cantor Lectures.

our E.M.F. equation to be constant, as I have done hitherto; but we must assume that it decreases slightly as the armature current increases. Graphically, this is represented in fig. 5, where the current flowing through the armature is measured on the horizontal, O C, and the field strength is represented by the inclined full line above. If there were no armature reaction the field strength would be given by the dotted horizontal line. If the speed is to remain constant, the counter E.M.F. must be proportional to the field strength; and, by suitably altering the scale (with which we measure the ordinates in the diagram), we can take the top line to represent counter E.M.F. I have accordingly marked it E E.

The vertical distance, O E, represents now the supply E.M.F.; and, when the motor is running light, this is, of course, equal to the counter E.M.F. Now, let a load be thrown on, causing a considerable increase of current. The counter E.M.F. need now not be quite so large as before, since part of the supply E.M.F. has been already absorbed by the resistance of the armature circuit, and the counter E.M.F. need only balance the remainder. We find thus, that the supply condition of constant voltage requires the counter E.M.F. to become lower, as the power demanded from the motor increases. At the same time, the working condition of constant speed can only be attained by a lowering of the counter E.M.F. as the current increases; and it is, therefore, perfectly obvious that, if the lowering of the counter E.M.F., as determined by either condition, is the same, we must have constant speed at variable power—that is, a self-regulating motor. Generally, the line, E E, in the diagram representing counter E.M.F. is not quite straight, but slightly curved, presenting the concave side to the axis of abscissæ; whilst the line representing resistance loss through armature is, of course, quite straight. If we so design the machine as to get exactly the same speed, when running quite light and fully loaded, the speed will be slightly less at half load, but the difference can only be very small. I am able to show you this property of the shunt motor to be almost perfectly self-regulating, by means of the apparatus here before you.

Thus, you see, that the shunt motor is an excellent machine for keeping the speed constant when worked on a constant pressure circuit. The only drawback to its employment is, that a resistance must be inserted into the armature circuit at starting; but this may be done automatically, by placing the resistance permanently in circuit, and causing it to be short circuited by means of a centrifugal regulator fixed to the armature shaft, and so arranged that when the speed has attained a certain value the balls fly out and close a switch. Such an automatic device is also of value in case the motor should be over-loaded. If this should happen the speed will drop, and the resistance will be automatically re-inserted, keeping the current within safe limits. By these means a customer of an electric light company is prevented from taking from the mains more current than he has contracted for.

Before leaving the subject of speed regulation on constant pressure circuits, I must briefly allude to a system in use on electric tramways. Motors for tramcars are not required to run at a constant speed, but they are required to have a wide range of torque. At starting, or when running up hill, the speed may be low, but the static effort must be great. These motors are therefore generally series wound, and provision is made by means of a compound switch for inserting a larger or smaller number of field magnet coils, so as to vary the field strength according to requirements. The arrangement of the motors under the floor of the car is shown in the diagrams on the wall, which represent respectively the cars of Mr. Reckenzaun, the Electrical Engineering Company, and the General Electric Power and Traction Company, but time will not permit of my going into the details of the various designs.

When current is supplied to the motor, not from a general system of mains, but from a special generator serving no other purpose, the regulation of speed and power can be effected equally well by series, compound, or shunt machines. As regards the latter, I need not go into details, as this case is really included in the case of supply at constant pressure which I have already fully treated. After what I have said about this case, you will also readily see that compound wound motors with the main coils demagnetising are equivalent to shunt motors with large armature reaction, and that in fact a shunt motor with very small armature reaction, such for instance as a multipolar machine, may be made self-regulating by the addition of demagnetising main coils on the field magnets. I shall later on give you details of a large transmission plant carried out on these lines, and need therefore not go further into the subject now. There remains then only the plain series motor to be considered.

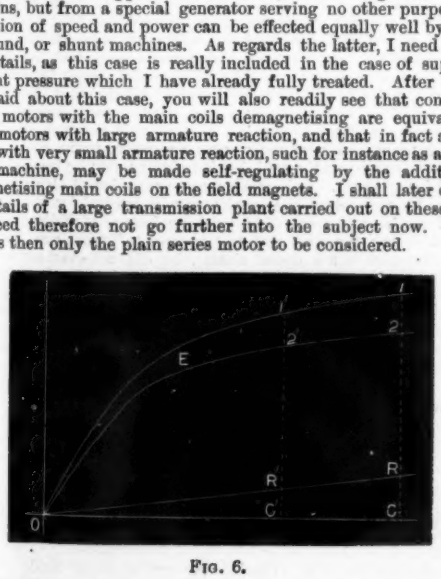


Fig. 6.

In this case both the generating and the receiving dynamo are series wound, and it is easy to see that by suitably designing these machines we can bring it about that the motor will run at a constant speed under varying loads if the generator is kept running at a constant speed at all times. Let the two curves in fig. 6 represent the E.M.F. characteristics of the two machines, the upper curve referring to the generator and the lower to the motor. These curves give the useful E.M.F. after deducting armature reaction, and refer of course to constant speed in each case. The current flowing through the circuit is that which we obtain by dividing the difference between the ordinates of the two curves by the total resistance. The resistance is of course a constant and the curve representing current and difference of E.M.F. is therefore a straight line, O R, in the diagram. The vertical length, C R, gives the voltage loss with a current, O C, due to resistance, and this must be equal to the voltage difference, 1, 2, between the curves. This determines therefore the speed of the motor for that particular current. Suppose the lower curve is the E.M.F. characteristic for that particular speed. Now let us throw some of the load off, then the current will assume a smaller value, say O C′. The voltage loss is now C′ R′, and the voltage difference 1′ 2′. If the E.M.F. characteristic fits this new working condition then 1′ 2′ must be equal to C′ R′, and the speed will remain the same as before We thus find that if we so design the machines that the difference between their E.M.F. characteristics at any working point is equal to the voltage loss by resistance, we obtain a perfectly self-regulating system of power transmission. Most of the transmissions now at work have been designed by taking advantage of this very valuable quality of series machines, but I must state at once that, in actual practice, the case is not quite so simple as I have here represented it. One of the difficulties met with is that we cannot always get the two characteristics to fit each other exactly over the whole range of output; another difficulty arises from there being generally a slight difference between the ascending and descending characteristics; but the most serious obstacle to quick and perfect regulation is the self-induction of the field magnets, especially if the machines are large. The self-induction prevents the rapid response of one machine to the other, which is required to make the regulation absolutely perfect. A sudden change of load cannot be followed immediately by a corresponding change in the power supplied to the motor, as time is required by the magnets to settle down into the new working condition; and during the transitory period, which may last many seconds, there is a surging of power to and fro which creates fluctuation of speed. To mitigate this evil, Herr Dobrowolsky, of the Berlin Electric Company, has devised a plan by which a kind of electrical damper is applied to the generator in the shape of a non-inductive high resistance placed across the terminals of the magnet coils as a shunt, and left there permanently. Any abnormal wave of E.M.F. which might otherwise disturb the working of the motor or endanger the insulation of either machine, spends itself in heating this resistance, and the disturbance quickly subsides.

The Line.

I pass now to the consideration of the line, a subject of great importance, especially in long distance transmission, since in these cases the cost of the line forms a very large item in the total cost of plant. You are all familiar with Sir William Thomson's law for greatest economy in conductors. Briefly, the reasoning on which this law has been developed is as follows. The annual cost of power delivered is made up of two items. First, the cost of the power only, and, secondly, the interest on the capital outlay. The cost of power includes that amount which is wasted in heating the conductor. If I, therefore, wish to work with the greatest economy, the sum of annual interest on the capital outlay and cost of power wasted must be a minimum; and this condition is attained when the two are equal. Profs. Ayrton and Perry were the first to question the practical applicability of this law. In a paper read by them before the Institution of Electrical Engineers in March, 1888, they showed that, under certain conditions, better economy can be obtained by departing from, instead of following, Sir William Thomson's law. I do not propose to give you quotations from their paper, which is highly mathematical, but I will endeavour to put the subject before you in a different way, requiring only very little mathematical treatment.

First of all, let us see, in a general way, what Sir William Thomson's law really means. It supposes that the annual electrical horse-power has a definite value at any place reached by the conductor. This is generally assumed for the distributing system as carried out from central stations. Whether a customer lives 100 yards or 500 yards from a central station, the company charges him the same for the current. But the assumption is not, strictly speaking, correct. To see this, let us suppose that the cost to the company of putting an annual horse-power into their mains is £20, and they get £30 for every annual horse-power taken by the customer. Now, if I lose one horse-power, shall I be right in writing off this loss at £20? Clearly not; for if I had not lost this particular horse-power, I might have sold it for £30. But there is another way of looking at this. You might say that the £10 difference between the cost and selling price of power represents profit and interest of plant and mains, and that, therefore, the lost power should be debited at net cost. To this I reply, that my object is not to put power into the mains, but to take power out, or, rather enable my customers to take power out, for which they will pay me; and so we might keep arguing the question, without ever coming to a definite understanding. Now, if we cannot settle such a simple problem by common sense reasoning, there must be something wrong in our premises; and in this case, it is not difficult to see where the hitch is. It is in the assumption that the power has a constant value. In reality, this is never the case. If it were the case—that is to say, if one horse-power had the same value at the motor end as it has at the generator end of the line—it would be perfectly useless to establish a transmission plant; it would be like carrying coals from Cardiff to Newcastle. It is only because the power has a great value at the motor end of the line, and a small value at the generator end, that it will pay us to lay out capital in plant, and incur the risk of working it.

The correct way of treating this problem is, therefore, to take into account the cost of the power, both at the generating and at the

receiving station. We must, further, take into account not only the interest and depreciation of the line, but also the interest and depreciation of the machinery at either end; and, in estimating these items, we must know at what voltage the plant is to work, and what total power is required; for the prime cost per horse-power depends very materially on the total power and voltage. To make this clear: if I want to reduce the capital outlay on the line, I must work at high voltage, and with a large energy loss. This means, that I must put down a larger generator than would otherwise be required, and, moreover, one that gives a high-pressure current. It is thus quite possible that, what I save in the line, I shall have to expend at the generating station, to say nothing of the increased charge for waste power, and the greater liability to have a breakdown, owing to high voltage.

You see this problem is a very complicated one; and Thomson's law, which says nothing about voltage or cost of machines, will not fit it. It is, however, possible to amend this law, so as to obtain at least an approximate solution. The premises on which the formula has been deduced are as follows:—

Conditions given.—Annual value of brake horse-power at generating station; voltage at generator terminals; brake horse-power required at motor end; distance of transmission; cost per horse-power of machines and regulating appliances at the given output, and voltage; cost of conductor, per ton of copper erected; interest, and depreciation of whole plant.

MOST ECONOMICAL CURRENT FOR ELECTRIC POWER TRANSMISSION.

D ... ... Distance in miles.
a ... ... Section of conductor in square inches.
E ... ... Terminal volts at generator.
e ... ... Terminal volts at motor.
HP_g ... ... Brake horse-power required to drive generator.
HP ... ... Brake horse-power obtained from motor.
c ... ... Current in amperes.
Efficiency of generator 90 per cent.; efficiency of motor 90 per cent.
g ... ... Cost in £ per electrical horse-power output of generator.
m ... ... Cost in £ per brake horse-power output of motor including regulating gear.
$G = 9\,g\,HP_g$ Cost in £ of generator.
$M = m\,HP_m$ ... Cost in £ of motor and regulating gear.
$t = 18{\cdot}2\,D\,a$ ... Weight in tons of copper in line.
K ... ... Cost in £ per ton of copper including labour in erection.
s ... ... Cost in £ of supports of line per mile run.
p ... ... Cost in £ of one annual brake horse-power absorbed by generator.
q ... ... Percentage for interest and depreciation on the whole plant.

$$\text{Capital outlay} = g\frac{E\,c}{746} + m\,HP_m + D\,s + \frac{1{\cdot}6\,K\,D^2c^2}{E\,c - 830\,HP_m} = A.$$

$$\text{Annual cost per brake horse-power delivered} = q\frac{A}{HP_m} + p\frac{HP_g}{HP_m}.$$

Put

$$B = \frac{E\,p}{670} + q\frac{E\,g}{746}$$

$$\gamma = \frac{830}{E}\,HP_m,$$

the current which would be required if the line had no resistance, and

$$\beta = \gamma^2\,\frac{E\,B}{1{\cdot}6\,q\,K\,D^2 + E\,B};$$

then the most economical current at the given voltage, E, is

$$c = \gamma\left(1 + \sqrt{1 - \frac{\beta}{\gamma^2}}\right)$$

$$c = \gamma\left(1 + \sqrt{\frac{1{\cdot}6\,q\,K\,D^2}{1{\cdot}6\,q\,K\,D^2 + B\,E}}\right)$$

For very long distances the term under the square root approaches unity and the most economical current the value 2γ; from which it follows that under no circumstances will it be economical to lose more than half the total power in the line.

Data required.—Working current; brake horse-power at generating station; mechanical efficiency; voltage at motor; total capital outlay per brake horse-power delivered; and cost of annual brake horse-power.

The efficiency of each machine is assumed to be 90 per cent. The formula gives only the current, but the other data can be found by very simple calculations which need no explanation. The cost of supports for the line per mile, whether overhead or underground, can be taken as constant, that is, not depending on the exact current within the limits, which can easily be foreseen in each case; and it therefore does not enter into the formula for the current. Interest and depreciation I have taken the same for all parts of the plant, so as to avoid too great a complication of the formula. If you now work out by the aid of the current formula the same transmission problem for different voltages, you will find that there is one particular voltage for which the annual cost of the brake horse-power delivered at the motor end of the line is a minimum; and, provided this voltage is within reasonable limits, it ought to be adopted. When making such calculations, you will find that the greater the cost of power at the generating station, the higher is the most economical voltage, this voltage also, of course, increasing with the distance.

Each case must be worked out with due regard to local conditions, and nothing in the shape of cut and dried rules or figures can make this work superfluous. On the other hand, it is very desirable to collect information as to the cost of works which have actually been carried out, and by the liberality of Mr. Brown, the engineer to the Oerlikon Works, Switzerland, I am able to place before you some figures of this kind which are contained in the following table. The figures give the whole capital outlay for the electrical parts of some of the power transmissions erected by this firm.

COST OF TRANSMISSION OF POWER PLANT.

Distance in miles.	H.P. delivered.	Speed of machines.	Cost in £.			Total cost.*	Cost per H.P.
			Gen.	Mot.	Line.	£	£
1·870	85	450	640	560	440	1,880	22·2
·280	195	500	760	680	132	1,800	9·7
·280	51	600	320	280	60	720	14·1
·375	90	550	520	480	80	1,240	13·8
·560	71	600	440	400	C0	1,040	14·6
·280	40	700	260	240	20	640	16
·375	75	600	480	440	68	1,120	15
·500	87	500	520	480	100	1,260	14·5
1·560	150	600	760	720	330	2,050	13·7
·220	93	450	440	420	232	1,270	13·7
6·250	11	900	132	110	480	960	87
2·200	51	600	360	320	300	1,140	22·4
·187	60	900	240	220	18	600	10
5·000	41	750	240	200	344	1,020	24·8
3·750	220	600	1,040	960	640	2,960	13·5
·062	15	600	112	104	8	252	16·8
·260	19	700	160	160	20	390	20·5

* This includes regulating apparatus, instruments, posts, insulators, lightning arresters, erection, and supervision.

THE EDISON INCANDESCENT LAMP CASE IN AMERICA.

(*Concluded from page 57.*)

The next important thing was the Edison platinum lamp. Early in 1879 Edison produced a platinum lamp strikingly like the carbon lamp of the present patent. He made an application for a patent in the United States in April, 1879, and almost contemporaneously made application for foreign patents. The French patent issued in June, 1879; the American patent not until May 4th, 1880, being therefore later than the patent in suit; but the invention had entered into the art before the making of the invention of the patent in suit, for it had been described in newspapers and crystallised in foreign patents. Handing a copy of the French patent to his Honour, Mr. Duncan pointed out that there was the highly exhausted glass chamber made entirely of glass with two platinum leading-in wires sealed into it by fusion, and connected in the exhausted chamber with a great length of very fine platinum wire coiled on to a bobbin. The American patent says that the function which high resistance plays, is "to enable a large number of lamps to be used in multiple arc," which his Honour would not forget was set forth by the plaintiff as an important feature of this discovery. Gen. Duncan then read a long extract from the French patent, and pointed out that therein was fully set forth the relation which should exist between the size and proportions of the burner of the incandescent lamp, and the quantity of material necessary to be used in the outside circuit for conveying the current to the lamp. What was true in relation to a lamp having a metallic burner was no less true in relation to a lamp having a carbon burner, and whenever Mr. Edison or Lane-Fox, or anyone preceding them, had announced that principle, there could be no invention in subsequently applying it to lamps employing a different material for a burner. It became a mere question of electrical engineering. He understood the gentleman who opened for the plaintiff to put forth, as the great distinguishing feature of Edison's invention, that he was the first man to "appreciate" (that was the word he used, not once but a dozen times), he did not even say to "discover," but that he was the first man to "appreciate," at its full value, the relation that high resistance joined to small radiating surface sustained to economy of copper in the conductors. Therefore, he says, the patent in suit is to be sustained with a broad interpretation. "We say," said Gen. Duncan, "that that principle is old in the art." Edison knew it. He had given it to the world—perhaps supposing himself to be the discoverer of it—through various patents, long before he made the invention, which alone can be found in the patent in suit; months before "the great flood of sunlight came upon the art of incandescent lighting" (to borrow his own expression) he had not only described this thing, but had taken a patent for it.

A significant fact bearing upon this point is revealed by an examination of the proceedings in the Patent Office relating to this platinum lamp patent. When that application was filed, it contained this claim:

"In combination with a sealed vacuum chamber made entirely of glass a continuous incandescent *metallic* conductor as set forth."

After the allowance of the patent in suit, Mr. Edison substituted for the claim just read, this one with which this patent issued:—

"In an electric lamp, the combination with a hermetically sealed vacuum chamber made entirely of glass, of metallic conductors passing

through the glass and around which the glass is melted, and an *incandescent* conductor placed in the electric circuit, substantially as set forth."

The word "metallic" has disappeared from the incandescent metallic conductor of the original claim. That claim was broad enough to include all sorts of burners, whether made of metal or of carbon, or of any composition of matter; it was so intended. Prof. Barker testified that it is a broader claim than any claim of the patent in suit. Now, what was the meaning of it? After having secured the allowance of the patent in suit, they take this earlier application, elaborately setting forth the theory of the relation of high resistance plus small radiating surface to the wires of the circuit, and insert a broad claim that will cover both carbon and platinum lamps. If they have any patent on that subject matter it is No. 227,229, the platinum lamp patent, and not the patent on the carbon burner. The full significance of that change was that whatever plaintiffs might think to-day, at that moment they could not have regarded the carbon patent as covering this principle of electrical engineering. It was not patentable at that date to any human being. It was as free as the air we breathe or the sunlight that beams upon us. His Honor might be interested to know why suit was not pressed on patent 227,229. That patent was in suit once, but was withdrawn by reason of a certain adjudication on the Bate patent in the Supreme Court. He supposed, at least, that that was the explanation, but at all events, that patent was originally made part of the subject of controversy in this cause; and the language of the bill glorifying Mr. Edison for his great work in this art is to be read in connection with that patent—wherein he has undertaken to patent a problem in electrical engineering—as well as in this one, in which he has coiled up a little piece of tar putty, stuck it into a globe, and said "that is a great invention too." They might be met with the question whether the platinum lamp was a practical lamp. He did not feel called upon to answer that question, but was free to say that it had not obtained commercial use; it had quickly been followed by better lamps. Nobody questions that carbon is a better material than platinum. Mr. Edison and others had found that out, and it had been known beforehand. There was a difficulty in manipulating carbon to get a sufficiently high resistance. A wide field was open there for all inventors, and when one man found one method, and another another method, of taking carbon and bringing it into a filamentary form and having it stand, then lamps were made that were better than platinum lamps and that are in use to-day. The great field for invention then opened for the world was how to make a burner that would satisfy the necessary engineering requirements. If Mr. Edison could make a high resistance carbon burner by rolling lampblack and tar into a fine wire and carbonising it, he was entitled to a patent, if it was new. If it was better adapted for wide distribution by coiling it into a close spiral, for that also he might have been entitled to a patent. What he was contending for, however, was this great principle—which gentlemen propose to credit to Mr. Edison—of the relation between high resistance and small cross section of the burner, and the amount of copper required to carry the current from the dynamo to the lamp, was not and could not be a part of the patent in suit. Gen. Duncan then cited the Khotinsky French patent of 1875 and the American patent of Woodward in 1876, as showing arrangements of incandescent lamps in multiple arc. He then passed to the consideration of the Lane-Fox patent and pointed out that it revealed, as fully as Edison's French patent, the relation between high resistance in the burner and the amount of copper required in the conductor.

Referring to the work of Sawyer and Man, Gen. Duncan said, that early in 1878 they were engaged in the development of a system of incandescent lighting; they operated with small carbons less than a millimetre in diameter, some of them but $\frac{1}{61}$th of an inch in diameter. The principal point in connection with them was, that the material was shaped before carbonisation, and that they were exceedingly small—much smaller in cross-section than many of the commercial lamps of the present day. Summing up the prior state of the art, Gen. Duncan contended that the utility of carbon as an incandescent burner was well-known; so was the utility of the high vacuum to protect the carbon; so was the desirability of making the receiver entirely of glass; the use of fine leading-in wires of platinum; the arrangement of lamps in multiple arc; the necessity of giving the burner a high total resistance in order to secure wide distribution in multiple arc; the idea of making the burner of small cross-section; the manufacture of carbons by carbonising a mixture of lampblack and tar. There were other things not explicitly described, perhaps not more than hinted at in these earlier patents and publications, which are found in Mr. Edison's patent, for instance, the securing the carbon burners to the leading wires by carbonisable plastic cement. This appeared to be new with Mr. Edison. He had got a thing which he calls a "filament" but he had not defined it. He says it is so fragile it cannot be clamped; therefore he had to devise a new mode of securing it to the leading-in wires, and that seems to be one of the essential things of the filament. He also speaks of the filament as being made from carbon of high resistance. It is assumed from Edison's own testimony that that means a carbon that is purely structural. That is a carbon, the product of carbonisation, made without subjecting it to any process that would reduce its specific resistance. The extreme importance of this distinction would be seen further on, for defendant's carbons are treated so that their specific resistance is vastly lower than that of purely structural carbon. In Edison's English patent, 3,765, of 1880, is found the following: "The practice, so far as known, has been to make them of as low resistance as possible, that is, low specific resistance—a porous carbon having been used which was dipped or soaked in some carbonisable liquid until its pores were filled, and then subjected to recarbonisation, which process was repeated until the pores of the original carbon were filled with carbon. By this process the resistance of the carbon is lessened while its liability to disintegration under high heat is increased." Now, note that he says: "*Such carbons are unfit for use in electric lamps giving light by incandescence.* For such lamps, Edison has discovered that the incandescing material should have the highest possible resistance in very small bulk, and be capable of resisting the disintegrating effects of very high heats and the absence of atmospheric pressure," and further that "*carbons which are purely structural in character alone possess these qualities.*" By "purely structural" is meant a carbon wherein the natural structure, cellular or otherwise, of the original material is preserved unaltered; that is, not modified by any treatment which tends to fill up the cells or pores with unstructural carbon, or to increase its density or to alter its resistance. Now, if that is the kind of carbon from which Mr. Edison in this patent proposes to make the burners of his lamps, they were not disposed to contest the novelty of his invention. Another possible feature of novelty disclosed in the patent in suit is the use of a carbon of a total resistance of 100 ohms. They did not think there was anything patentable in that, but stress seemed to be laid upon it in the patent. There were at least half a dozen statements in evidence by Mr. Edison, that at least 100 ohms were essential. It was assumed, therefore, that he intended to limit himself to that as a minimum; and so far as a carbon burner was concerned, that—for all that appears to the contrary in the record—was novel with Edison, even if not patentable. Another feature on which great stress was laid, the novelty of which they were not disposed to contest, was the coiling of the thing called a filament into a close spiral, so that only a portion of the external surface should have an active and efficient radiating surface. The prior state of the art did not show that this method of manufacturing the burner of an incandescent lamp had been resorted to. Mr. Edison dwells upon it with emphasis as performing a very important function. He was not asserting that it was patentable, but that it was the first time the thing had been distinctly announced. There had been a coiling of platinum, but it had not been stated that it was for the purpose of diminishing the radiating surface.

Certain points were formulated by Prof. Barker as important elements in the invention of the patent. He credits Edison with making a new departure in the art embracing the following features: (1) The carbon burner with small cross section and small radiating surface, even when of considerable length; (2) a filamentary burner of porous carbon of high resistance; (3) a filamentary burner first formed and then carbonised; (4) an all glass bulb as distinguished from a separable chamber with cemented joints. As to the first feature, Gen. Duncan contended that it exhibited no invention. Prof. Cross says the value of the principle is wholly independent of the material of the burner, and had always been recognised in the case of platinum. He testifies that it is a mere application of the commonest principles of electrical engineering at that time familiar to those skilled in the art. His testimony is confirmed by Shallenberger, a graduate of the Naval Academy, competent by education and experience to pass an opinion upon the question, being familiar with the firing of torpedoes electrically by platinum fuses placed in multiple arc.

He would not say that the questions put to Edison on this subject had been dishonestly evaded, but they certainly had not been met in a frank and manly manner. It had been sought to search the conscience of this inventor; to know whether he really believed he had made a great discovery as to the relation existing between high resistance and small radiating surface and the amount of copper in the circuit. He hoped the court might find time to read every word of Mr. Edison's deposition when called as a witness. He read among other extracts the following from Mr. Edison's testimony: *Q.* "Do you consider yourself the discoverer of that relation?" *A.* "I do not consider myself the discoverer of Ohm's law. It will explain all things that have been done and probably everything that will be done in the next thousand years in electricity." *Q.* "I ask you whether you consider that you are the person who discovered the relation between the size and proportions of the burner and the character of the conductors conveying the current to each lamp, when being used in multiple arc?" *A.* "I do not know whether I am or not in relation to an incandescent lamp. Ohm's law does not mention incandescent lamps. It is a general law." So he went on, and presently began to quarrel again with Ohm's law, *Q.* "Didn't you know as a matter of inference from Ohm's law, that with a given size of conductor it would be necessary to give the individual lamps a higher resistance if they were to be used in multiple arc, than if they were to be used in series?" *A.* "It is not necessary in applying Ohm's law at all, but when you bring in the commercial element, then it is; *the fact of the matter is, that at the time I experimented on the incandescent lamp I did not understand Ohm's law.*" *Q.* "Do you mean that you did not know the formula of Ohm's law at that time?" *A.* "No, sir; I did not know it." *Q.* "When did you first get knowledge of Ohm's law?" *A.* "*It may seem strange for me to state that I do not understand Ohm's law to-day.*" *Q.* "I do not ask you whether you understand it, but when did you first know of it?" *A.* "I have heard of Ohm's law for the last twenty years." *Q.* "What do you mean by saying that you did not know Ohm's law at the time you began experimenting with incandescent lamps?" *A.* "*I mean to say that I did not understand Ohm's law. I do not understand it now and I do not want to understand it. It would prevent me from experimenting.*" *Q.* "Why?" *A.* "Because I would try to figure it out mathematically; *I have employed a great many mathematicians; they have all been dead failures.*" *Q.* "Does that include Mr. Upton?" *A.* "Yes, sir, in his mathematical capacity."

His Honour would see that they got no answer to their question. They had put Mr. Edison a fair question, intended to search his conscience, as to whether he believed he was the discoverer of that wonderful relation between the proportions of the burner, and the character of the circuit; the thing which formed the burden of the opening argument; the thing in which the great merit of this invention was supposed to consist, was this relation. They were fairly

entitled to an answer to the question. But Mr. Edison flies into a quarrel with one of the great laws of nature; says that he does not understand it; doesn't know, nor want to know, what it is! Were they to believe that he, of all men, did not understand Ohm's law; one of the fundamental laws of electricity taught to children in primary schools? It was incredible. It was his method of avoiding an answer to that question; nothing more. It was a masterful performance in one aspect. When a knot was presented to Alexander which could not be untied, he cut it; so Mr. Edison evaded this question by a method not fair nor ingenious; it stands to-day on the record unanswered. There are other things betraying a similar real or assumed ignorance by Mr. Edison. Judging from his language, he honestly believed when he gave his testimony, that in 1879 he made for the first time the grand discovery that in an all-glass chamber, exhausted by a torricellian pump, a permanent high vacuum could be maintained. For the first time he came to know, what the rest of the world had known for a decade, that there was such a mechanism as a Sprengel pump, and he pats himself on the back, retires behind his own ignorance, and thinks he is a wonderful inventor! He takes his own ignorance as an understanding as to what constitutes invention! On the question of how much invention there was in proportioning the size of the burners and the copper in the circuit, the plaintiff's expert, Clarke, says there are no specific directions in the patent and none were necessary. When asked whether if all Mr. Edison had ever done had been to make, by the process described by the patent in suit, a single lamp, which had proved durable under test, it would have been the practical solution of the problem of the subdivision of the electric light, he answered yes; and why? Because persons skilled in the art would have at once known how to construct other lamps having burners properly proportioned for use in large numbers in multiple arc. Dr. Chandler has also expressed the opinion that mere engineering and mechanical skill was sufficient to adapt the old lamps to render them available for use in large numbers in multiple arc. Dr. Barker has said that an important feature of Edison's so-called "new departure" was in shaping the material for the burner before carbonisation. But there was no novelty in that. Edison does it here with the plastic material. Carré and others had done that. Dr. Barker, on cross-examination, testified that he had done it himself in 1854.

At this point the court adjourned for the day.

Gen. DUNCAN, resuming the next morning, said he wished to call attention to Dr. Barker's deposition, which was read from a paper prepared beforehand and which, it was fair to presume, had undergone the inspection of counsel of the Edison Company and might therefore be regarded as a brief from the other side. Now he would ask was there any invention in October, 1879, in putting a piece of carbon, irrespective of its shape, into an exhausted globe made of one piece of glass? Again he would ask, if to-day a method were devised of making a carbon largely superior to anything that Mr. Edison has made, would invention be involved by substituting the superior for the inferior carbon? He apprehended not. Dr. Barker, when asked whether a person skilled in the art wouldn't know perfectly well that in such a lamp any defect arising from a mechanical joint could be obviated by uniting the parts of the glass by fusion, replied that method would readily suggest itself to one skilled in the art, as the method was known more than twenty years ago. The testimony of Dr. Barker and Prof. Brackett was enough to dispose of the contention that there was any merit in sealing up a piece of carbon in an all glass globe in October, 1879. Mr. Schallenberger testifies to the entire practicability of making a lamp in two portions with a mechanical seal. Was the assumption a tenable one, that the patent in suit, singled out of hundred of others made by Mr. Edison, and hundreds of others made by other men, is the one thing that has created a new art or even measureably developed an art which has existed before. The defendant's position was that the lamp in suit was a most inferior structure, and, in fact, made no more impression on the art than the platinum lamp of 1878. The latter lamp did cause a sensation and the depression of the gas shares in 1878, and gave *éclat* and notoriety to Mr. Edison, but the lamp of the patent was worthless. It was not until the art had progressed beyond these useless lamps that the world began to realise the value of an incandescent lamp. Prof. Chandler in his testimony considered it was not any of Mr. Edison's lamps that solved the problem of the electric light, it was a system of distribution for which the world had been waiting.

As the result of this consideration of the prior state of the art, Gen. Duncan said it might fairly be concluded that Edison did not invent the burner of an incandescent lamp; a thing having a small cross-section combined with small radiating surface; nor a thing having high resistance combined with small radiating surface; nor was he the originator of the conception of high total resistance of the burner, which economically affected the question of copper in the mains; nor did plaintiffs believe it was patentable to Mr. Edison to make use of a peculiar kind of carbon which he calls "purely structural carbon;" by a process in which the operation stops when the raw material has been carbonised, and nothing is done to increase its density. Nor was it patentable to reduce the raw material to shape before carbonising it, nor merely to enclose a carbon in an all-glass highly exhausted globe.

The defendants did not believe that Edison created a new art, nor that he discovered a new physical property in carbon; and if they were right in their contention upon those points, they should argue that the only thing new to Mr. Edison, or revealed in this patent, was either his mode of preparing the carbon of the burner, leaving it in that condition of high porosity that contrasts with the old carbons and with the art; or his mode of shaping that carbon into a spiral form, or else his mode of attaching that peculiarly constructed thing to the leading-in wires. They believed that under any plausible interpretation of the patent the invention must be confined to these three matters.

The term "filament" is not used until the specification comes to a burner made of tar-putty. The invention is said to consist in "a light-giving body of carbon wire or sheets." Neither term is defined in the patent. The French word for the instrument which we call a draw-plate is "filière," and "fil" is the French word for the thing produced by its use; a wire, a thing drawn through a filière; his Honour would observe the analogy between the French words and the English word "filament." As the word "wire" is used six times in the patent, and the word "filament" only twice, the natural conclusion would be that it is a thing which might be all the way from three to five thousandths of an inch up to a quarter of an inch or even larger. It was, of course, unnecessary to say that the third claim was limited by the precise language of the specification. Now the second paragraph in the statement of invention referred to the peculiar construction given in the first paragraph. "The invention consists in placing *such* burners of great resistance in a nearly perfect vacuum," and so on. What kind of a burner was called for by the previous section? Plainly one that was coiled; coiled not inadvertently, but in pursuance of a well-defined plan, whereby Mr. Edison proposed to secure the two valuable features of construction which he says lie at the very foundation of wide distribution of electric light on the multiple-arc principle; and if we can interpret the claim by reference to this paragraph, his invention consists in putting into that chamber such a burner as is spoken of in the previous paragraph; a burner so organised as to get that high degree of resistance which comes from coiling it, and thus making a part of its radiating surface.

There were three points in claim 1 demanding special attention. The filament is to be made of carbon of high resistance; it is to be made as described, and it is to be secured to metallic wires, as set forth. The witnesses on both sides seem to be agreed that high resistance means high specific resistance, and according to Dr. Barker, the standard by which to measure specific resistance is that of the old carbons. The question then, as regards infringement is whether defendants' burners are made of carbon as high, or higher, than the standard set up by this patent. Are they materially higher than that of carbons that were old in the art? Evidently Dr. Barker, when he gave his testimony, did not suppose that defendants' carbons were of lower specific resistance than the majority of the old carbons, and when, at length, it had been made plain to him that the resistance of defendants' carbons was just about the same as that of the old arc-light carbons, he found it necessary on redirect examination to give a most extraordinary piece of testimony. He said: "Well, a fair interpretation of that language is that the carbon of claim 1 must have a higher resistance than some of the old carbons, but not necessarily as high as others." He tells us he deliberately picked out only the lowest of the old carbons; he says he found carbons in the prior state of the art higher in their specific resistance than the carbons of the defendants' lamps. They should rely, therefore, upon the measurements made by Dr. Moreton of prior carbons, in connection with the testimony given in the first deposition of Dr. Barker, in support of the proposition that defandants had no such high specific resistance as that contemplated by claim 1 of the patent. They would contend that the conditions in claim 1 were that the filament is to be made as described, and that it is to be made by "carbonisation pure and simple," without any supplemental process that would induce a lowering of resistance. Gen. Duncan supported this position by numerous quotations from the testimony of Dr. Barker and from that of Mr. Edison himself. The other condition, "secured to metallic wires as set forth," in view of the language of the specification, meant the application of a carbonisable plastic material to the joint and carbonising it *in situ*. He would next briefly consider whether there was any hidden meaning in the word "filament" which would be of service to the defendant. He would say frankly to the court that he did not know what the word filament meant, but he thought, nevertheless, the plaintiff was committed to certain limitations in regard to it. If the condition of 100 ohms of total resistance when in action is imposed upon this burner by the word filament, then the defendants were outside the second claim as regarded two of their lamps.

The plea of brother Dyer was that the court should not interpret the meaning of filament to be limited to a resistance of 100 ohms, because by means of distribution now known, the defendants can employ lamps of less resistance than at date of patent. Mr. Edison calculated that the lamps must be at least 100 ohms to compete successfully with gas, therefore the conclusion was, the term filament was understood by Mr. Edison to mean a thing having a resistance hot of not less than 100 ohms. What else it may have meant was a mystery to them. They had received no light from the experts, nor from the brief, nor from the argument of the complainants' counsel. The term never appeared in the art of electric lighting until embodied by Mr. Edison in this patent; and under every obligation which the law imposes upon an inventor seeking the wide protection of the statutes, he was bound to define that term with exactness. Another definition which the plaintiffs' counsel might make the word filament to imply, that a filament was of so small a cross section that the platinum wire conveying current to it can be sealed into the globe by fusion. The old "rods," they said, required a wire so thick that it could be sealed into the glass. Here, said Gen. Duncan, is an exhibit showing seven carbons running from an extremely tenuous one up to one quite thick. Now these largest burners were larger than any burner used at the present time. Here again were two Sawyer and Man lamp carbons, smaller than some shown in the exhibit. Here is a Bernstein lamp and there a Thomson-Houston lamp; they are series lamps, and show burners which, he supposed, brother Dyer would say were filaments and not rods; perhaps he would say they were rods because they were not filaments, but they were quite large, and he did not know why they should not be called "rods" or not be called filaments.

Gen. Duncan said he would next pass to the consideration of a

certain application filed by Mr. Edison in the Patent Office a little later than the patent in suit. While the application for the patent in suit was pending, Mr. Edison had filed what is known as the "paper-carbon application," in which he had described a burner of paper, and sought to secure a patent on it. A long interference controversy with Sawyer and Man followed, and the latter obtained, as the result of that controversy, the patent that was before Judge Bradley in the McKeesport suit. Subsequently, Mr. Edison divided off from that application a portion not in interference with Sawyer and Man, which, having undergone several modifications, was still pending at the Patent Office. It came to the belief of defendants that claims co-extensive with those of the patent in suit, under the interpretation the plaintiff is endeavouring to impose on that claim, were contained in that application. They called upon the plaintiffs to furnish a copy of that application; they had declined. After a year's litigation they had to produce the application. Among the claims were the following:—

"An electric lamp for giving light by incandescence, consisting of a filament of high resistance and flexible carbon hermetically sealed within an enclosing globe made entirely of glass, substantially as hereinbefore set forth."

The Patent Office rejected the application as not presenting anything patentable over the patent in suit. The applicants said that the claims presented covered vital improvements and advances in the art which had made Mr. Edison's system the success it was. His inventorship had not been disputed, and he was entitled to protection therefor. The Patent Office replied that the claim of both the patent in suit and the application were for substantially the same invention, viz., a high resistance carbon. After a long correspondence, the Patent Office took the position that if Mr. Edison was not entitled to make a claim in a re-issue because the public would be defrauded of some of its rights, he was certainly not entitled to claim it in a patent which would cover the same ground as a re-issue, and continue two or three years after the original had expired. Gen. Duncan thought that his Honour would find that this document was very material to the interpretation of the patent in suit. Not only did this application throw a bright light on the proper interpretation of this patent, but it threw a strong side light upon the laches of the plaintiff in bringing suit. He had referred to the competition that was going on from 1880 to 1885, when this suit was filed. The complainants say they did not take action before because the defendants were not doing them harm enough. That was simply childish. The explanation was to be found right here: the Edison Company did not believe during those years that the patent now before the Court was the fundamental patent which they now assert it to be. They did not bring suit until that application in the Patent Office had drifted into that position where they felt powerless to secure what they originally asserted under it to be their rights. Then they said, "We have nothing to lose by taking our chances on patent 223,898."

Gen. Duncan then proceeded to discuss the question of jurisdiction as affected by the statute relating to the limitation of the term of an American patent by a prior foreign patent. And in conclusion, Gen. Duncan said that the contention of the defendants in regard to the patent was that it did not meet the stern requirements of the patent law. Mr. Edison did not in his patent describe the invention in such terms as would enable a person skilled in the art to make and use it, nor the best mode in which he had contemplated applying the principle of his invention; nor did he particularly point out and distinctly claim, as required by the statute, the things which he claimed to be his invention or discovery. There was absolutely no definition of the term filament in the patent, and complainants' experts have shown themselves to be utterly incompetent to define it. So of the word carbonisation; the patent has not undertaken to specify what that term signifies. What did Mr. Edison mean by carbonisation? If but one method was known to him at that time—the old method by the furnace—and that would not answer in dealing with the tar-putty filament which he describes as the best mode of carrying out his invention, then the patent failed, because it was not operative. Mr. Howell had been obliged to resort to a method of carbonising in order to make his test lamp, which was not known to the art at the date of the patent in suit. Mr. Edison has said in the most explicit language, that electrical heating in a vacuum is carbonising: that the preliminary work was not carbonising; it was only charcoaling, and that the real carbonisation was done when the electric current was put through the carbon.

It came, therefore, down to this point: Upon the testimony of Prof. Thomson; upon the experiments made by Mr. Howell by the plaintiff; it stood practically confessed by the Edison Company as impossible under this patent to make the thing described, without resorting to practices not known to the art at the date when the patent issued. If Mr. Edison knew that electrical carbonisation on the pumps was necessary in order to make a serviceable carbon, he was bound to put it into his patent. Defendants would say further, upon his own testimony, that he did know; because when asked how long he had been carbonising his burner by that method, he replied, "From the very beginning;" then he was asked whether the very first lamps made by him in 1879 were so carbonised, and he said, "Yes." Thanking his Honour for his patient attention, he would now yield to his associate.

PROCEEDINGS OF SOCIETIES.

Physical Society, June 26th, 1891.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

OWING to an examination being conducted in the Physical Laboratory of the Royal College of Science, the meeting was held in the Central Institution of the City and Guilds of London Institute.

Mr. J. Enright, B.Sc., was elected a member of the Society.

The following communications were made:—

THE CONSTRUCTION OF NON-INDUCTIVE RESISTANCES, by Prof. W. E. AYRTON, F.R.S., and Mr. T. MATHER.

In making some transformer tests about three years ago, the authors had occasion to consider the construction of electric conductors, the impedances of which should be practically equal to their resistances. This condition could only be fulfilled by making the inductance small in comparison with the resistance, and as the former does not depend on the material employed (excepting iron), it was important to use substances of high specific resistance. Carbon or platinoid being available, the latter was chosen on account of its low temperature co-efficient. One form of resistance exhibited consisted of strips of thin sheet platinoid about 6 metres long and 4 centimetres wide. Each was bent at the middle and doubled back on itself, thin silk being placed between the contiguous parts, and narrow ribbon used to bind the parts together. Twelve such strips arranged in series had a resistance of 2·95 ohms, and would carry a current of 15 ampères without changing its resistance more than $\frac{1}{10}$th per cent. This strip resistance was made by Messrs. C. G. Lamb and E. W. Smith, who at that time (1888) were students in the Central Institution, and to whom the authors' best thanks are due for the praiseworthy manner in which they surmounted the difficulties which presented themselves. Another form of resistance designed for portability, consisted of bare wire spirals, each length having a left-handed spiral placed within a right-handed one of slightly larger diameter, and the two being connected in parallel. This device was found to reduce the inductance to $\frac{1}{10}$th or $\frac{1}{20}$th of that of a single spiral, according as the diameters of the spirals approach towards equality. When the spirals are made of platinoid wire, the ratio of inductance to resistance is very small, averaging about $\frac{1}{500000}$.

ON POCKET ELECTROMETERS, by C. V. BOYS, F.R.S.

This communication described modifications of electrometers adapted for portability. As quartz fibres increase the delicacy and diminish the disturbing influences affecting instruments, much smaller controlling forces can be employed than when silk is used for suspensions. He had, he said, pointed out some time ago, the great advantages arising from making galvanometers small. Applying similar reasoning to electrometers, he remarked that making an instrument one tenth the size of an existing one reduced the moment of inertia of the needle to $\frac{1}{10^5}$ whilst the deflecting couple for given potentials would only be one-tenth of its former value. The small instrument would, for the same periodic time be 10,000 times more sensitive than the large one, provided the disturbing influences could be reduced in the same proportion. This, however, was not ordinarily possible, for any method of making contact with the needle, such as by a fine wire dipping into acid or mercury, prevented very small controlling forces being used. Still by suitable devices a large proportion of the full advantages could be obtained; a freely suspended needle without liquid contacts was essential to success. The first instrument described was one in which the needle was cylindrical, contiguous quarters being insulated and connected to the opposite ends of a minute dry pile placed within the needle; opposite quarters were thus at the same potential, and at a different potential to the other pair of quarter cylinders. This was suspended within a glass tube silvered on the inside and divided into four parts by fine longitudinal lines. In such an instrument the needle and quadrants are reciprocal, and the deflection depends on the product of the difference of potential between the quadrants and that between the parts of the needle. Owing to the dry pile not being constant the instrument was found unreliable, but when working at its best a Grove cell would give 30 or 40 millimetres deflection. The next step was to make a cross-shaped needle of zinc and platinum, and rely on contact electricity to keep the parts of the needle at different potentials. This bold experiment proved remarkably successful, for the instrument was very sensitive. A disc shaped needle with quadrants alternately zinc and platinum was then employed, and by this a small fraction of a volt could be measured. The weight of the disc was only $\frac{1}{10}$th of a gramme, and the instrument could be turned upside down, or carried about in the pocket with impunity. Another small instrument with the stationary quadrants of zinc and copper was exhibited, and by rotating them through an angle of 90°, so as to bring them in a different position relative to the parts of the needle, a deflection of several degrees of arc was produced. In the course of his remarks Mr. Boys made several suggestions relating to ballistic electrometers and electrostatic Siemens dynamometers, and pointed out the possibility of instruments such as he had exhibited being of use in elucidating the obscure points in connection with so-called "contact electricity."

The PRESIDENT complimented Mr. Boys on the beautifully simple and remarkably sensitive electrometers exhibited. He remembered that some years ago Mr. Gordon made a very small electrometer, but its insulation was insufficient for electrostatic work. He agreed with Mr. Boys as to the advantages of small instruments, providing sparking across or tilting of the needle could be prevented. On the other hand, he thought the use of small potential differences on the needle was a step in the wrong direction when great sensibility was required.

Prof. PERRY asked if the needle could not be kept charged by occasional contacts with a charged acid cup.

Mr. BOYS said he had originally intended using a fairly highly charged needle, but had not yet done so. He also suggested that an electrometer of very small capacity might be made by reducing the quadrants surrounding a disc needle until they became like small tuning forks.

A paper on ELECTRIFICATION DUE TO THE CONTACT OF GASES

WITH LIQUIDS, by Mr. J. ENRIGHT, B.Sc., and one on THE EXPANSION OF CHLORINE BY HEAT, by Dr. ARTHUR RICHARDSON were taken as read.

The following correction should be made in the report of the meeting on June 12th. For the first sentence in Mr. Blakesley's remarks on Dr. Lodge's experiments substitute:—"Mr. Blakesley asked whether the pitch of the resonant jars altered when the distance between the circuits was varied, for according to theory the mutual induction should diminish the self-induction and cause the oscillations to be more rapid.

The French Physical Society.*

M. MASSIN gave the results of some measurements of capacity and self-induction, taken on overhead telegraph and telephone wires. These were published in the ELECTRICAL REVIEW for July 31st.

ALTERNATING CURRENT MOTORS, BY M. E. HOSPITALIER.

The distributions of electrical energy by alternating currents are comparable, in number and power, in America at least, to similar distributions by continuous currents, but they would soon outnumber the latter if we knew how to turn to advantage the electrical energy distributed in an alternating form for electro-chemical operations into which electrolysis enters; if we knew how to store up the electrical energy supplied by these currents; and lastly, if we knew how to convert this electrical energy readily into mechanical work. For all these applications, the continuous current has, up to the present, been preferred to alternating currents. But the inconveniences that we have just mentioned are in a great measure compensated for by a number of advantages, among which may be mentioned the simplicity of construction and economy of alternating current machines or alternators, the easy production, either directly or by transformation, of very high electromotive forces, whereas it is difficult to exceed 3,000 volts with continuous currents; simplicity and facility of insulation; and lastly, facility and simplicity of transformation, by means of inert apparatus, containing no movable parts, and giving a very high efficiency, reaching 95 per cent. If the utilisation of alternating currents for electro-chemical operations and for the storage of the electrical energy which they convey, is a problem that has scarcely as yet received serious consideration, and the partial solutions of which still remain within the domain of experiment, the same cannot be said of alternating current motors; the principles applied and the various types based on one principle, are already so numerous, that they admit of a classification which is summed up in the following table:—

A.—Constant Field or Synchronous Motors.

Separate excitation	Magnets.	Magneto-alternators.
	Electro-magnets.	Dynamo-alternators.
Self-excitation	Redressed current	Zipernowsky.

B.—Alternating Field Motors.

Series dynamo. Continuous current motors with foliated inductors.
Shunt dynamo. Continuous current motors with foliated inductors.
Electro-dynamic motors. The E. Thomson meter.
Field partially redressed. Mordey.
Closed armature. E. Thomson.

C.—Revolving Field Motors.

Ordinary or single circuit alternators		Ferraris.
		Tesla.
		Schallenberger.
		Hutin and Leblanc.
Alternators with multiple phases or with polyphased currents	3 wires and 2 currents	Ferraris.
		Tesla.
		Borel.
	3 wires and 3 currents	Dolivo-Dobrowolsky and Brown
		Haselwander.
		Bradley.
		Wenström.

An alternating motor does not differ essentially in its general principles from a continuous current motor; we always find the same two essential parts, a system producing a magnetic field or *inductor*, and an induced system, or armature, turning in relation to one another; but, whereas the magnetic field of continuous current motors is always constant, that of alternating current motors is, as the case may be, constant, alternating or revolving.

A. Motors with a constant field.—This kind of motor, which was the first tried, is based on the principle of the reversibility of the alternators. The alternating current is sent into a series of induced bobbins moving in a constant magnetic field produced by a magnet or electro-magnet. The simplest consists of a double T Siemens bobbin turning between the prongs of a magnet or of an electro-magnet excited by a foreign source; if the armature is started at an angular speed, corresponding to the frequency of the alternating current furnished by the alternator (50 turns per second, for instance, if the frequency of the alternating current is 50), the movement of the induced bobbin will continue synchronically, and will follow all the variations in speed of the alternator, unless a resistant couple exceeding a certain value should be suddenly applied upon the axle; the time in which synchronism ceases and the motor stops is generally very short. The theory of these motors was developed in 1884 by Dr. Hopkinson. The necessity of bringing about the synchronism at the beginning of exciting the inductors by a foreign source in the case of high powers, and of maintaining a rigorously constant angular speed, has prevented these motors from being used extensively for industrial purposes. M. Zipernowsky has overcome two of the most serious drawbacks to these motors by making them self-exciting, the excitation being supplied by a shunt in which is introduced a current reverser; the motor is started automatically, provided that the charge is suppressed, and the starting is effected when disconnected; it rapidly attains the required angular speed, which it afterwards maintains invariably, notwithstanding the sudden variations in the resisting torque.

The rendering of these motors is most satisfactory, amounting to 80 per cent. for a motor of 4 kilowatts. Notwithstanding, or, to speak more correctly, on account of the synchronism necessary to the working of these motors, they have been applied in several instances to the transport of motive force to a distance.

B. Motors with an alternating field.—Every continuous current dynamo fed by alternating currents can start and turn, producing an appreciable mechanical power, as it may be compared to an electro-dynamometer the torsion couple of which remains always of the same sign, notwithstanding the reversals in the nature of the current. But a motor of this construction has many serious defects; the frequent reversing of the current develops in the cores of the inductors Foucault currents, which considerably reduce the efficiency of the motor if we do not take the precaution to laminate these inductors: the high coefficient of self-induction in the circuits of the motor reduces the effective intensity, and consequently the specific power or output of a motor of given dimensions.

For these reasons, motors of this type are little used, except in cases where low power only is required to be produced; we may mention, for instance, the motors which work small domestic ventilators expending 1 to 2 ampères at an effective difference of potential of 50 volts, these apparatus being now used extensively in America. The excitation of these motors is sometimes arranged in a shunt and sometimes in series. By suppressing the iron in the inductors and armatures, we can also realise an electro-dynamic motor of low specific power, but its motive couple is, at each moment, in proportion to the product of the intensities of the currents passing through the inductors and the armature respectively. The motor of Prof. Elihu Thomson's electrical energy meter is the type of electro-dynamic motors.

In order to avoid losses through Foucault currents and through hysteresis arising from the rapid reversing of the magnetisation in the inductors of motors with an alternating field, M. Mordey has proposed to make the alternating current pass through a reverser mounted on the axle of the motor. At the moment of starting, the action of this reverser is nil, but as the angular speed increases, the current passing through the motor is acted upon more and more, *i.e.*, the frequency of the reversals diminishes, and thus the losses caused by these reversals are reduced and the efficiency is improved.

The motors with closed armatures may also be included in the class of motors with an alternating field. Prof. Elihu Thomson's experiments on electro-dynamic repulsions have shown that a closed circuit placed in an alternating field has a tendency to become displaced so as to bring its coefficient of mutual induction to a minimum, *i.e.*, so as to reduce to a minimum the flow of force passing through it. If we place in this alternating field a series of elementary bobbins movable round a common axis, and if a system of brushes, suitably arranged, short circuits each of the bobbins at the moment when the flow passing through it is at its minimum, and opens the circuit when the flow becomes nil, leaving it open until the flow reaches its maximum again, each of these bobbins will be subjected to a force, and will consequently produce a motive torque, which the multiplicity of bobbins renders to all intents constant. In this motor there is no connection between the inductive circuit and the armature. The inductive circuit is metallically closed on the wires coming from the generator, the induced circuit is closed upon itself. The experiment can easily be made with a small Gramme or Rechniewsky machine of two poles, care being taken to loosen the brushes to the extent of about 45° in the direction of the rotation. Alternating field motors are little used, and up to the present no experiments indicating their efficiency have been published.

C. Motors with a revolving field.—In March, 1888, M. Ferraris indicated for the first time the principle of alternating current motors, the present development of which leads us to foresee within a short time a complete revolution both in the transport of powerful motive forces to great distances and in the distribution of electrical energy for motors of low power. This is the principle established by M. Ferraris: When two alternating currents of the same period, but with a lag of a quarter of a period, pass through two circuits arranged in a rectangular form, the resultant of each of the two magnetic fields which would be produced by each circuit if it acted alone is a revolving magnetic field of constant intensity and uniform angular speed, making a complete revolution in one period. If we place in this revolving field a circuit closed upon itself, it will be the seat of induced currents, and these induced currents will tend to make the induced circuit turn in the same direction as the field. With the exception of the mode of production of the revolving field, the rotation thus obtained is similar to that of the experiment known by the name of Arago's magnetism of rotation.

We may also say, and more correctly, that the motor with a revolving field works in virtue of the Foucault currents of which it is the seat. These Foucault currents would be nil if the circuit maintained the same position in the field, *i.e.*, if the circuit turned at the same angular speed as the field, and it is in order to satisfy this condition of relative immobility that the circuit turns in the field and in the same direction; the circuit *follows* the field.

Although a comparatively recent invention, the motors with a revolving field, are already very varied as regards principle and arrangement. They are distinguished chiefly by the mode in which the revolving field is produced and by the generator which feeds the motor. We will examine first the ordinary alternating current motors,

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* *Résumé* of the papers read at the sitting of July 17th, 1891.

and then the motors fed by alternators with multiple phases producing many phased currents.

a. Ordinary alternators.—There are several methods which will enable us to obtain, with an ordinary alternating current, two alternating currents with a lag of a quarter of a period, capable, consequently, of producing a revolving field.

M. Ferraris has proposed to employ two circuits, the first being fed directly by the alternator, and the second by the secondary circuit of a transformer, the primary circuit of which is connected in derivation with the alternator. M. Tesla has proposed and employed two circuits in derivation presenting very different constants of time. M. Schallenberger arranges an induced circuit closed upon itself and placed obliquely with regard to the primary circuit fed by the alternator. In Messrs. Hutin and Leblanc's motor which was presented at our last sitting, the revolving field is produced by two series of bobbins connected in derivation, but with a condenser introduced into one of the circuits. Thus the lag of a quarter of a period which is necessary for the production of the revolving field is very easily obtained.

b. Alternators with multiple phases, or with many-phased currents.—The apparatus described are suited to the distribution of motive force, and to the feeding of motors of moderate or low power. For the transport of high powers, it is preferable to employ special generators, producing not an ordinary alternating current, but several alternating currents lagging for the fraction of a period required, *i.e.*, *polyphased* alternating currents.

We may employ, as the simplest solution of the problem, *two* currents conveyed by four wires, or three wires only if a common return wire be used. Arrangements of this kind have been suggested by Messrs. Ferraris and Tesla. Assuming that it is necessary to use three wires, it is preferable to employ them in the production of *three* currents of equal periods, but with a lag of a third of a period, profiting by the fact that for three currents lagging in this manner the algebraic sum of the intensities is always nil, each wire serving as a return wire for the currents passing through the other two circuits at the same instant. This is the principle of motors with polyphased currents realised less than two years ago by Messrs. Dolivo-Dobrowolsky, Haselwander, Bradley and Wenström. The transport of a motive force of 300 horse-power based on currents of this nature and now in course of preparation between Lauffen and Frankfort-on-the-Main, a distance of 175 kilometres, will be effected by means of three-phased currents generated at low tension, and transformed at high tension (20,000 to 30,000 volts) by insulated petroleum transformers constructed specially for the purpose by Mr. Brown. On their arrival, these currents will be again transformed into currents of low tension by a transformer similar to the first, and finally sent into a motor with a revolving field and three-phased currents.

The special interest of these experiments, the results of which are awaited with impatient curiosity, lies in the expectation of being able to state definitely that alternating currents are better suited than continuous currents to the production, transformation and canalisation of electrical power represented by high potentials and low intensities. The motors with revolving field are, moreover, apparatus with metallically closed circuits, and are consequently not capable of giving rise to any extra current sparks or any dangerous breakage, the only interruption necessary being that of the commutator used for starting or stopping the machine, and, in this case, every precaution can be taken to obviate all danger.

This brief enumeration of the methods employed or proposed for the convenient and economical transformation of the electrical energy of alternating currents into mechanical work shows that we may now consider the problem solved. The same will no doubt soon be able to be said of the utilisation of alternating currents for electro-chemical operations in which electrolysis and the storage of electrical energy play a part; the industrial importance of alternating currents will then be much greater than that of continuous currents, and we shall witness a new evolution of electrical processes, while awaiting that reserved for us by alternating currents of very high frequency.

NEW PATENTS—1891.

12,703. "Improvements in or connected with switchboards for electrical purposes." T. HAWKINS. Dated July 27th.

12,720. "Improvements in electric coal-cutting and mineral-cutting machines." A. T. SNELL. Dated July 27th.

12,726. "Improvements in the construction of armatures for certain kinds of electrical machines." W. P. THOMPSON. (Communicated by W. Lahmeyer and Co., Germany.) Dated July 27th.

12,727. "Improvement in the method or means of regulating motor dynamos or continuous current transformers." W. P. THOMPSON. (Communicated by W. Lahmeyer and Co., Germany.) Dated July 27th.

12,731. "An automatic locomotive or electrical engine." C. S. F. MELLOR. Dated July 27th.

12,774. "A new electro-dia-magnetic self-rotating dynamo." O. FRANCIS. Dated July 28th.

12,799. "Improvements in and relating to system of electric distribution." M. FIELBOGEN. Dated July 28th. (*Complete.*)

12,801. "An improved pulley arrangement for conducting the haulage cable around curves on cable tramways." N. H. RICHARDS. Dated July 28th. (*Complete.*)

12,824. "An improvement connected with electric lighting apparatus." G. ZANNI. Dated July 28th.

12,828. "Improvements relating to electric motors chiefly designed for railway and other vehicles, and to electric generators." H. H. LAKE. (Communicated by the Thomson-Houston International Electric Company, United States.) Dated July 28th. (*Complete.*)

12,831. "Improved curative electric belt." W. RUSSELL. Dated July 28th.

12,834. "An improved electric apparatus for treating deafness." W. W. HORN. (Communicated by G. F. Webb, United States.) Dated July 28th.

12,859. "A method of and means for combining at will, telephonic communication with ordinary methods of electrical signalling in or about coal and other mines and works, and other places." G. WILSON. Dated July 29th.

12,898. "Improvements in means to be employed in the electrical deposition of copper." T. PARKER. Dated July 29th.

12,904. "Improvements in holders for incandescence electric lamps." R. A. SCOTT. Dated July 30th.

12,934. "An electrical parcel exchange system." A. R. BENNETT. Dated July 30th.

12,946. "Improvements in the electro-deposition of platinum." I. A. TIMMIS and W. H. WALENN. Dated July 30th.

12,960. "Improvements in electric transformers." W. M. MORDEY. Dated July 30th. (*Complete.*)

12,982. "An electric automatic time check" F. G. M. WETHERFIELD. (Communicated by C. K. Jardine, Demerara.) Dated July 31st.

12,985. "Improvements in means or apparatus for use in automatic electric railway signalling." R. B. ANNESLEY, J. H. EVANS, and E. BLAKEY. Dated July 31st.

13,015. "Improved electric insulator." G. H. GRAHAM and T. GANNANE. Dated July 31st.

13,070. "Improvements in or relating to the construction and erection of telegraph or similar posts, and in appliances for use in connection therewith." G. C. DYMOND. (Communicated by C. Bourdon, France.) Dated August 1st. (*Complete.*)

13,087. "Improvements in electric apparatus for maintaining a uniform, or approximately uniform, temperature within a chamber or vessel, specially applicable to incubators." A. M. ELTON. Dated August 1st.

13,096. "Improvements relating to conduits applicable for combined use as casings for electrical conductors and for gas supply or for either use separately." J. A. MCMULLEN. Dated August 1st.

13,108. "Improvements in the manufacture of metallic boxes or cases for containing electric bells." T. BARTON. Dated August 1st.

13,114. "Improvements in or connected with electric furnaces." T. PARKER. Dated August 1st.

13,124. "Improvements in heating and welding by electricity." H. HOWARD. Dated August 1st.

13,125. "Improvements in carbon holders and screens suitable for electric welding." H. HOWARD. Dated August 1st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

7,487. "Improvements in electromotors." H. FREEMAN. Dated May 14th. 8d. Claims:—1. An electric motor, in which a series of electro-magnets, capable of rotating bodily about the motor-shaft and of being alternately magnetised and demagnetised, have their poles arranged opposite a corresponding series of armatures, which are held immovable during the successive energisings of the magnets, but receive a limited amount of movement about the axis of the shaft and away from the magnets during each successive demagnetisation of the same, all retrograde movement of the armatures being prevented by a ratchet and pawl arrangement or its equivalent as described, either the pawl or the ratchet, or their equivalents respectively, being a fixture, whilst the complimentary member of the device rotates with the shaft, substantially as described. 2. In an electric motor, an electro-magnet and a magnet armature, both mounted independently upon a common axis, in combination with devices, substantially as described, whereby the magnet and armature alternately receive an impulse in the same direction about said shaft, substantially as described. 3. The arrangement of contacts on the machine armature and magnet, in combination with the automatically operated switch lever, and the various contacts and electric conductors connected with the same, whereby the alternate forward movements of the machine armatures and magnets are automatically controlled, substantially as described.

8,474. "Improvements in electrical switches." C. A. MCEVOY. Dated May 31st. 8d. The inventor constructs an electric switch in such a manner that the contact pieces which have to be brought together to complete an electrical circuit are brought together by endway pressure upon a press button, and are released and allowed to move away from one another by giving a partial turn to this same button. 4 claims.

8,720. "Electro-magnetic brake for railways for reducing high speeds." H. E. WALTER. Dated June 5th. 8d. The inventor provides for reducing the speed of trains travelling at high speeds by means of the reaction produced by causing Foucault currents to be induced in a stationary line of metal by magnets carried by the train with their poles in close proximity to the line of metal. 6 claims.

8,854. "Improvements in and relating to apparatus for measuring electrical energy." L. A. W. DESRUELLES and R. F. O. CHAUVIN. Dated June 7th. 8d. Comprises a voltameter which is traversed by the

electric current to be measured, and in which the relative position of the electrode is changed by the electro-deposition due to the action of the current, the said electrodes serving alternately as anode and cathode, and such change of position of the electrodes being utilised for effecting the reversals of the current. The said apparatus also comprises mechanism which is actuated by an electric motor, or by one or more electro-magnets, when the circuit of such motor or magnet is completed by the voltameter, and the object of which is to effect the different operations which the apparatus has to perform, namely, the distribution or commutation of the current, the interruption of the circuit of the said motor or magnet, and the movement of the mechanism for registering the amount of electrical energy measured by the apparatus. 7 claims.

9,261. "A new or improved electric arc lamp. E. T. HEADECH. Dated June 16th. 8d. Claims:—1. A lamp with a single frame and gear plate in one casting. 2. An adjustable balance weight, to counter balance the weight of solenoid core and carbon holder as shown and described. 3. A focussing arrangement as shown and described, and by the drawings. 4. An electric arc lamp composed of the aforenamed arrangements and as shown by the drawings.

20,289. "Improvements in and relating to the manufacture of insulating compositions for electrical uses." T. D. BOTTOME. Dated December 12th. 4d. The inventor employs powdered silicon dioxide (otherwise known as quartz), selecting that of the very finest state of division to be found in the market; he then drys the powder by subjecting it to a moderate heat for the purpose of eliminating and freeing it of dampness, occluded gases, and other objectionable substance or impurities. He then takes a sufficient quantity of a solution of the crude sodium or potassium silicate of about 40° Beaume, to make a plastic mass with the previously prepared powdered quartz, to which is added about 3 to 5 or more per cent. of colouring substances when some particular colour is desired, these ingredients are then thoroughly and intimately mixed together, and so proportioned that a workable plastic mass of doughy consistency is formed, portions of the mass so prepared are placed or forced in moulds and pressed or otherwise shaped by suitable mechanical means into such articles as may be desired. The articles thus formed are placed in a warm place and allowed to become thoroughly dry and hard, they are then subjected to a red heat which results in all the volatile matter being driven off, so as to leave nothing but pure oxide of silica behind in a very hard and coherent state. 3 claims.

CORRESPONDENCE.

Subsidy by Specification.

We agree with Messrs. The Henley's Telegraph Works Company, Limited, that the grievance they mention with regard to the specification of a certain maker's wire is one which is working unfairly to the electric light contractor, and means should be sought of remedying this evil; but we think that if Messrs. Henley are desirous of finding a remedy, the tone and substance of their letter is not calculated to do any good.

In calling the system "subsidy by specification," and asking for "a fair field and no favour," they are no doubt impressing the mind of any outsider with an idea that some unfairness or subsidy, or perhaps underhanded means are going on, either on the part of the engineer or inspector specifying that particular manufacture of wire. We feel certain that Messrs. Henley do not wish to convey such an impression, and that they are seeking the reason for the evil in the wrong direction. We have, during the last 10 years, had dealings with almost every consulting electrical engineer, inspectors of fire insurance companies, and others issuing specifications, and we can distinctly certify that any imputation of the above nature cannot be justified, and that, with hardly any exception, they are fair dealing men anxious only to specify the best article to be obtained.

No! the reason for the evil, about the existence and the unfairness of which there can be no doubt, lies elsewhere; it lies simply in the want of a *standard specification* for electrical wires. The present mode of expressing the specification of a certain quality of wire is inadequate, misleading, and useless. To specify that the insulation resistance of a certain kind of wire should be many hundreds of megohms is an antiquated form introduced by telegraph engineers, and no doubt very useful and proper in the case of the determination of the quality of, say, a submarine cable, but it is worthless in the case of the quality of electric light wire, and has given rise to a great deal of contention in the trade. It is well known that although wire of a certain insulation might have been specified, yet it is impracticable, almost impossible, to test the wire upon the same basis of insulation resistance after it has once been cut up and placed in the house; because, apart from other considerations such as being in circuit with other fittings, it is evident that a slight mechanical accident or fault may reduce the insulation resistance of the very best wire from 1,000 megohms to 100.

The other means at our disposal at present of specifying a certain quality of wire, that is, saying that it should be vulcanised or unvulcanised, braided or lapped, does also not convey a distinct and indisputable idea of the quality which is to be delivered, as it cannot distinctly determine the quality of the rubber nor its thickness, nor the quality of its mechanical protection.

Considering this want of a standard specification to go by, it is not at all surprising to us that an engineer or inspector, wishing to specify the best wire that can be obtained, flies to the only alternative he seems to have, and that is to specify a distinctive wire from a distinctive manufacturer.

It is not difficult to guess at the name of the manufacturers in the mind of Messrs. Henley and Company when writing their letter, and it seems to us quite natural that an engineer should specify that particular firm. Even we, as competitors, must acknowledge they are the most experienced manufacturers, with a reputation for independence, excellence of quality, and reliability second to no other.

It is evident, therefore, that the remedy of the evil lies with the electric wire manufacturers and suppliers, such as Messrs. Henley themselves, ourselves, and others. We should supply engineers and inspectors with a standard specification which will convey to their minds—and be recognised throughout the trade—a distinctive wire of a certain indisputable quality in every detail.

We acknowledge that it is almost impossible for any single firm at present to establish such a standard, but the combition of a number of firms, or a committee of the Institution of Electrical Engineers or the Chamber of Commerce, could easily, and without much trouble or expense, establish it.

But it is not only with regard to electrical cables and electrical wires that this evil exists; it also is, and even to a much larger degree existing with regard to almost all other supplies in use in electric light installations, such as switches, cut-outs, holders, and other electrical fittings.

The want of some sort of standard for these fittings is daily felt more and more, not only by the contractors and specifiers but also by the manufacturers themselves.

We have recognised this for a long time past, and have been working towards some sort of a solution, which we acknowledge is rather a difficult one, owing to the constant improvements being made; but we believe we have arrived at some standardising of our fittings, which can be used as a basis, and as we believe the matter is one of the greatest possible importance to the trade in general we propose, with your permission and help, to shortly publish the outlines of such standard specifications in your journal; and our Mr. Binswanger intends furthermore to submit the matter to the consideration of the Electrical Trades Section of the Chamber of Commerce.

The General Electric Company, Limited.
G. BINSWANGER, *Managing Director.*

Carbon Resistances.

As there has been a good deal of correspondence in your pages about the earliest use of carbon as a resistance, I send the following reference which I have come upon:—

"Mr. Howldy, of Hereford, an ingenious electrician, has by some novel experiments clearly proved the increased power of electricity if retarded in its progress; instead of using tubes of glass filled with water, as Mr. Woodward had done, he has employed a glass tube supplied with lamp black." (From "A Treatise on Atmospherical Electricity," by John Murray, F.S.A., London, 1830.)

J. Munro.

Electrostatic Induction.

Kindly allow me to correct an error which I have just noticed in last week's issue with regard to the above. The electrostatic field due to a charged condenser or to a battery is of course inversely proportional to the *cube* of the distance, not the square, as stated.

J. E. Taylor.

August 12th, 1890.